VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Marine Engineering

Scheme of Teaching and Examinations2021

Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2021 - 22)

III SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	BSC 21MAT31	Transform Calculus, Fourier Series and Numerical Techniques (Common to all Branches)	Maths	2	2	0	0	03	50	50	100	3
2	IPCC 21MR32	Manufacturing processes	MR	3	0	2	0	03	50	50	100	4
3	IPCC 21MR33	Material Science	MR	3	0	2	0	03	50	50	100	4
4	PCC 21MR34	Thermodynamics	MR	2	2	0	0	03	50	50	100	3
5	PCC 21MRL35	Machine Drawing and GD & T	MR	0	0	2	0	03	50	50	100	1
6	UHV 21UH36	Social Connect and Responsibility	Any Department	0	0	1	0	01	50	50	100	1
7	HSMC 21KSK37/47	Samskrutika Kannada	TD and PSB: HSMC	1	0	0	0	01	50	50	100	1
	HSMC 21KBK37/47	Balake Kannada										
	OR											
	HSMC 21CIP37/47	Constitution of India and Professional Ethics										
8	AEC 21MR38X	Ability Enhancement Course - III	TD: Concerned department PSB: Concerned Board	If offered as Theory Course: 1	0	0	0	01	50	50	100	1
				If offered as lab. course: 0	0	2	**0**	02				
								Total	**400**	**400**	**800**	**18**
9	**Scheduled activities for III to VIII semesters**	NMDC 21NS83	National Service Scheme (NSS)	NSS	All students have to register for any one of the course namely National Service Scheme, Physical Education (PE)(Sports and Athletics) and Yoga with the concerned coordinator of the course during the first week of III semester.The activities shall be carried out from (for 5 semesters) between III semester to VIII semester. SEE in the above courses shall be conducted during VIII semester examinations and the accumulated CIE marks shall be added to the SEE marks. Successful completion of the registered course is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the colander prepared for the NSS, PE and Yoga activities.								
		NMDC 21PE83	Physical Education (PE)(Sports and Athletics)	PE								
		NMDC 21YO83	Yoga	Yoga								
Course prescribed to lateral entry Diploma holders admitted to III semester B.E./B.Tech programs												
1	NCMC 21MATDIP31	Additional Mathematics - I	Maths	02	02	--	--	---	100	---	100	0

Note: BSC: Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **INT** –Internship, **HSMC:** Humanity and Social Science & Management Courses, **AEC**–Ability Enhancement Courses. **UHV:** Universal Human Value Course.
L –Lecture, **T** – Tutorial, P- Practical/ Drawing, **S** – Self Study Component, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Examination. **TD-** Teaching Department, **PSB**: Paper Setting department

21KSK37/47 Samskrutika Kannada is for students who speak, read and write Kannada and **21KBK37/47** Balake Kannada is for non-Kannada speaking, reading, and writing students.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both

by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (BE/B.Tech.) 2021-22 may be referred.

21INT49 Inter/Intra Institutional Internship: All the students admitted to engineering programs under the lateral entry category shall have to undergo a mandatory 21INT49 Inter/Intra Institutional Internship of 03 weeks during the intervening period of III and IV semesters. The internship shall be slated for CIE only and will not have SEE. The letter grade earned through CIE shall be included in the IV semester grade card. The internship shall be considered as a head of passing and shall be considered for vertical progression and for the award of degree. Those, who do not take up / complete the internship shall be declared fail and shall have to complete during subsequently after satisfying the internship requirements. The faculty coordinator or mentor shall monitor the students' internship progress and interact with them for the successful completion of the internship.

Non–credit mandatory courses (NCMC):

(A) Additional Mathematics I and II:

(1) These courses are prescribed for III and IV semesters respectively to lateral entry Diploma holders admitted to III semester of B.E./B.Tech., programs. They shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s to earn the qualifying CIE marks. These courses are slated for CIE only and has no SEE.

(2) Additional Mathematics I and II shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

(3) Successful completion of the courses Additional Mathematics I and II shall be indicated as satisfactory in the grade card. Non-completion of the courses Additional Mathematics I and II shall be indicated as Unsatisfactory.

(B) National Service Scheme/Physical Education (Sport and Athletics)/ Yoga:

(1) Securing 40 % or more in CIE,35 % or more marks in SEE and 40 % or more in the sum total of CIE + SEE leads to successful completion of the registered course.

(2) In case, students fail to secure 35 % marks in SEE, they has to appear for SEE during the subsequent examinations conducted by the University.

(3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have not completed the requirements of the course. In such a case, the student has to fulfill the course requirements during subsequent semester/s to earn the qualifying CIE marks.

(4) Successful completion of the course shall be indicated as satisfactory in the grade card. Non-completion of the course shall be indicated as Unsatisfactory.

(5) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

Ability Enhancement Course – III			
21MR381	Programming in Python (0-0-2-0)	21MR383	Chartering (1-0-0-0)
21MR382	Microcontrollers (0-0-2-0)	21MR384	Spreadsheet for Engineers (0-0-2-0)

27.09.2022

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(Effective from the academic year 2021 - 22)

IV SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	BSC 21MATME41	Complex Analysis, Probability and Linear Programming	Maths	2	2	0	0	03	50	50	100	3
2	IPCC 21MR42	Marine Electrical Technology	MR	3	0	2	0	03	50	50	100	4
3	IPCC 21MR43	Fluid Mechanics & Machinery	MR	3	0	2	0	03	50	50	100	4
4	PCC 21MR44	Basic Ship Knowledge and watch keeping	MR	3	0	0	0	03	50	50	100	3
5	AEC 21BE45	Biology For Engineers	BT, CHE, PHY	2	0	0	0	02	50	50	100	2
6	PCC 21MRL46	Mechanical Measurements & Metrology laboratory	MR	0	0	2	0	03	50	50	100	1
7	HSMC 21KSK37/47	Samskrutika Kannada	HSMC	1	0	0	0	01	50	50	100	1
	HSMC 21KBK37/47	Balake Kannada										
	OR											
	HSMC 21CIP37/47	Constitution of India & Professional Ethics										
8	AEC 21MR48X	Ability Enhancement Course- IV	TD and PSB: Concerned department	If offered as theory Course: 1	0	0	0	01	50	50	100	1
				If offered as lab. Course: 0	0	2	**0**	02				
9	UHV 21UH49	Universal Human Values	Any Department	1	0	0	0	01	50	50	100	1
10	INT 21INT49	Inter/Intra Institutional Internship	Evaluation By the appropriate authorities	Completed during the intervening period of II and III semesters by students admitted to first year of BE./B.Tech and during the intervening period of III and IV semesters by Lateral entry students admitted to III semester.				3	100	--	100	2
								Total	**550**	**450**	**1000**	**22**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

1	NCMC 21MATDIP41	Additional Mathematics - II	Maths	02	02	--	--	--	100	--	100	0

Note: BSC: Basic Science Course, IPCC: Integrated Professional Core Course, PCC: Professional Core Course, AEC –Ability Enhancement Courses, HSMC: Humanity and Social Science and Management Courses, UHV- Universal Human Value Courses.
L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

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27.09.2022

Non – credit mandatory course (NCMC):

Additional Mathematics - II:

(1) Lateral entry Diploma holders admitted to III semester of B.E./B.Tech., shall attend the classes during the IV semester to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s to earn the qualifying CIE marks. These courses are slated for CIE only and has no SEE.

(2) Additional Mathematics I and II shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

(3) Successful completion of the course Additional Mathematics II shall be indicated as satisfactory in the grade card. Non-completion of the courses Additional Mathematics II shall be indicated as Unsatisfactory.

Ability Enhancement Course – IV			
21MR481	Internet of Things (0-0-2-0)	21MR483	Maritime law (1-0-0-0)
21MR482	PLC and SCADA (0-2-0-0)		

Internship of 04 weeks during the intervening period of IV and V semesters; 21INT68 Innovation/ Entrepreneurship/ Societal based Internship.

(1) All the students shall have to undergo a mandatory internship of 04 weeks during the intervening period of IV and V semesters. The internship shall be slated for CIE only and will not have SEE. The letter grade earned through CIE shall be included in the VI semester grade card. The internship shall be considered as a head of passing and shall be considered for vertical progression and for the award of degree. Those, who do not take up / complete the internship shall be considered under F (fail) grade and shall have to complete during subsequently after satisfying the internship requirements.

(2) Innovation/ Entrepreneurship Internship shall be carried out at industry, State and Central Government /Non-government organizations (NGOs), micro, small and medium enterprise (MSME), Innovation centers or Incubation centers. Innovation need not be a single major breakthrough, it can also be a series of small or incremental changes. Innovation of any kind can also happen outside of the business world.

Entrepreneurship internships offers a chance to gain hands on experience in the world of entrepreneurship and helps to learn what it takes to run a small entrepreneurial business by performing intern duties with an established company. This experience can then be applied to future business endeavours. Start-ups and small companies are a preferred place to learn the business tack ticks for future entrepreneurs as learning how a small business operates will serve the intern well when he/she manages his/her own company. Entrepreneurship acts as a catalyst to open the minds to creativity and innovation. Entrepreneurship internship can be from several sectors, including technology, small and medium-sized, and the service sector.

(3) Societal or social internship.

Urbanization is increasing on a global scale; and yet, half the world's population still resides in rural areas and is devoid of many things that urban population enjoy. Rural internship, is a work-based activity in which students will have a chance to solve/reduce the problems of the rural place for better living.

As proposed under the AICTE rural internship programme, activities under Societal or social internship, particularly in rural areas, shall be considered for 40 points under AICTE activity point programme.

27.09.2022

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V SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	PCC 21MR51	Theory of Machines	MR	2	2	0	0	03	50	50	100	3
2	IPCC 21MR52	Marine IC Engines and propulsion system	MR	3	0	2	0	03	50	50	100	4
3	PCC 21MR53	Mechanics of Materials	MR	2	2	0	0	03	50	50	100	3
4	PCC 21MR54	Ship Structure and Construction	MR	2	2	0	0	03	50	50	100	3
5	PCC 21MRL55	Design laboratory	MR	0	0	2	0	03	50	50	100	1
6	AEC 21MR56	Research Methodology & Intellectual Property Rights	TD: Any Department PSB: As identified by University	2	0	0	0	02	50	50	100	2
7	HSMC 21CIV57	Environmental Studies	TD: Civil/ Environmental /Chemistry/ Biotech. PSB: Civil Engg	1	0	0	0	1	50	50	100	1
8	AEC 21MR58X	Ability Enhancement Course-V	Concerned Board	If offered as Theory courses: 1	0	0	0	01	50	50	100	1
				If offered as lab. Courses: 0	0	2	0	02				
								Total	**400**	**400**	**800**	**18**

Ability Enhancement Course – V

21MR581	Introduction to AI and ML (1-0-0-0)	21MR583	Seamanship and navigation (1-0-0-0)
21MR582	Sensors and actuators (1-0-0-0)		

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L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

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VI SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	HSMC 21MR61	Ship Operations and Management	MR	3	0	0	0	03	50	50	100	3
2	IPCC 21MR62	Marine Thermal Engineering	MR	3	0	2	0	03	50	50	100	4
3	PCC 21MR63	Naval Architecture	MR	2	2	0	0	03	50	50	100	3
4	PEC 21MR64x	Professional Elective Course-I	MR	3	0	0	0	03	50	50	100	3
5	OEC 21MR65x	Open Elective Course-I	Concerned Department	3	0	0	0	03	50	50	100	3
6	PCC 21MRL66	Analysis & SimulationLab	MR	0	0	2	0	03	50	50	100	1
7	MP 21MRMP67	Mini Project	MR	Two contact hours /week for interaction between the faculty and students.				--	100	--	100	2
8	INT 21INT68	Innovation/Entrepreneurship /Societal Internship	Completed during the intervening period of IV and V semesters.					--	100	--	100	3
Total									**500**	**300**	**800**	**22**

Professional Elective – I	
21MR641	Control Engineering and Marine Automation
21MR642	Marine Environmental Protection
21MR643	MEMS and Microsystem Technology

Open Electives – I offered by the Department to other Department students	
21MR651	Introduction to Ships and Shipping
21MR652	Supply chain Management and Introduction to SAP

Note: HSMC: Humanity and Social Science & Management Courses, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PEC:** Professional Elective Courses, O**EC**–Open Elective Course, **MP** –Mini Project, INT –Internship.
L –Lecture, T – Tutorial, P - Practical / Drawing, S – Self Study Component, CIE: Continuous I nternal Evaluation, SEE: Semester End Examination.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching – Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by CIE only and there shall be no SEE. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (BE/B.Tech) 2021-22 may be referred.

Professional Elective Courses(PEC):
A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five course. The minimum students' strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the programme is less than 10.

Open Elective Courses:
Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent Department. However, they can opt an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.
Selection of an open elective shall **not be allowed** if,

(i) The candidate has studied the same course during the previous semesters of the program.
(ii) The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
(iii) A similar course, under any category, is prescribed in the higher semesters of the program.

In case, any college is desirous of offering a course (not included in the Open Elective List of the University) from streams such as Law, Business (MBA), Medicine, Arts, Commerce, etc., can seek permission, at least one month before the commencement of the semester, from the University by

submitting a copy of the syllabus along with the details of expertise available to teach the same in the college.
The minimum students' strength for offering open electives is 10. However, this conditional shall not be applicable to cases where the admission to the programme is less than 10.

Mini-project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.
CIE procedure for Mini-project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.
The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
No SEE component for Mini-Project.

VII semester Classwork and Research Internship /Industry Internship (21INT82)

Swapping Facility
Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate research internship/ industry internship after the VI semester**.**
(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.
Elucidation:
At the beginning of IV year of the programme i.e., after VI semester, VII semester classwork and VIII semester Research Internship /Industrial Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for internship. In other words, a good percentage of the class shall attend VII semester classwork and similar percentage of others shall attend to Research Internship or Industrial Internship.
Research/Industrial Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, Centers of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations / institutes. The intership can also be rural internship.
The mandatory Research internship /Industry internship is for 24 weeks. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during the subsequent University examination after satisfying the internship requirements.

INT21INT82 Research Internship/ Industry Internship/Rural Internship
Research internship: A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.
Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.
Rural internship: A long-term goal, as proposed under the AICTE rural internship programme, shall be counted as rural internship activity.
The student can take up Interdisciplinary Research Internship or Industry Internship.
The faculty coordinator or mentor has to monitor the students' internship progress and interact with them to guide for the successful completion of the internship.
The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of internship.

27.09.2022

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Swappable VII and VIII SEMESTER

VII SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	PCC 21MR71	Marine Auxiliary Machinery & Systems	MR	3	0	0	0	3	50	50	100	3
2	PCC 21MR72	Engine Room Maintenance	MR	3	0	0	0	2	50	50	100	2
3	PEC 21MR73X	Professional elective Course-II	MR	3	0	0	0	3	50	50	100	3
4	PEC 21MR74X	Professional elective Course-III	MR	3	0	0	0	3	50	50	100	3
5	OEC 21XX75X	Open elective Course-II	Concerned Department	3	0	0	0	3	50	50	100	3
6	Project 21MRP76	Project work		Two contact hours /week for interaction between the faculty and students.				3	100	100	200	10
								Total	**350**	**350**	**700**	**24**

VIII SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	Seminar 21MR81		Technical Seminar	MR	One contact hour /week for interaction between the faculty and students.				--	100	--	100	01
2	INT 21INT82		Research Internship/ Industry Internship		Two contact hours /week for interaction between the faculty and students.				03 (Batch wise)	100	100	200	15
3	NCMC	21NS83	National Service Scheme (NSS)	NSS	Completed during the intervening period of III semester to VIII semester.				--	50	50	100	0
		21PE83	Physical Education (PE) (Sports and Athletics)	PE									
		21YO83	Yoga	Yoga									
									Total	**250**	**150**	**400**	**16**

Professional Elective – II

21MR731	Special Duty Vessels
21MR732	Marine Corrosion and Prevention
21MR733	Ship Fire Prevention and Safety

Professional Elective - III

21MR741	IMO and Maritime Conventions
21MR742	Marine Engineering Practice
21MR743	Shipping Trade

Open Electives - II offered by the Department to other Department students

21MR751	Ports and Terminal Management
21MR752	Transport and Logistics Management

Note: PCC: Professional Core Course, **PEC:** Professional Elective Courses, **OEC**–Open Elective Course, **AEC** –Ability Enhancement Courses.
L –Lecture, T – Tutorial, P- Practical / Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

Note: VII and VIII semesters of IV year of the programme

(1) Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate research internship/ industry internship after the VI semester**.**

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the programme.

PROJECT WORK (21XXP75): The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.
(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.
(iii) To impart flexibility and adaptability.
(iv) To inspire team working.
(v) To expand intellectual capacity, credibility, judgment and intuition.
(vi) To adhere to punctuality, setting and meeting deadlines.
(vii) To instill responsibilities to oneself and others.
(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

TECHNICAL SEMINAR (21XXS81): The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization.

(i) Carry out literature survey, systematically organize the content.
(ii) Prepare the report with own sentences, avoiding a cut and paste act.
(iii) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
(iv) Present the seminar topic orally and/or through PowerPoint slides.
(v) Answer the queries and involve in debate/discussion.
(**vi)** Submit a typed report with a list of references.

The participants shall take part in the discussion to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

Seminar Report:50 marks
Presentation skill:25 marks
Question and Answer: 25 marks.■No SEE component for Technical Seminar

Non – credit mandatory courses (NCMC):

National Service Scheme/Physical Education (Sport and Athletics)/ Yoga:

(1) Securing 40 % or more in CIE,35 % or more marks in SEE and 40 % or more in the sum total of CIE + SEE leads to successful completion of the registered course.

(2) In case, students fail to secure 35 % marks in SEE, they has to appear for SEE during the subsequent examinations conducted by the University.

(3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have not completed the requirements of the course. In such a case, the student has to fulfill the course requirements during subsequently to earn the qualifying CIE marks subject to the maximum programme period.

(4) Successful completion of the course shall be indicated as satisfactory in the grade card. Non-completion of the course shall be indicated as Unsatisfactory.

(5) These course shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

MARINE ENGINEERING

SEMESTER - III

B. E. (Common to all branches)

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES

Course Code	**21MAT 31**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives: The goal of the course Transform Calculus, Fourier series and Numerical techniques 21MAT 31 is

- To have an insight into solving ordinary differential equations by using Laplace transform techniques
- Learn to use the Fourier series to represent periodical physical phenomena in engineering analysis.
- To enable the students to study Fourier Transforms and concepts of infinite Fourier Sine and Cosine transforms and to learn the method of solving difference equations by the z-transform method.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods

Teaching-Learning Process (General Instructions):

ThesearesampleStrategies,whichteacherscanusetoacceleratetheattainmentofthevariouscourse outcomes.

1. Inadditiontothetraditionallecturemethod,differenttypesofinnovativeteachingmethodsmay be adopted so that the delivered lessons shall develop students' theoretical and applied mathematicalskills.
2. StatetheneedforMathematicswithEngineeringStudiesandProvidereal-lifeexamples.
3. Supportandguidethestudentsforself–study.
4. Youwillalsoberesponsibleforassigninghomework,gradingassignmentsandquizzes,and documenting students'progress.
5. Encouragethestudentsforgrouplearningtoimprovetheircreativeandanalyticalskills.
6. Showshortrelatedvideolecturesinthefollowingways:
   - Asanintroductiontonewtopics(pre-lectureactivity).
   - As a revision of topics (post-lectureactivity).
   - As additional examples (post-lectureactivity).
   - Asanadditionalmaterialofchallengingtopics(pre-andpost-lectureactivity).
   - Asamodelsolutionforsomeexercises(post-lectureactivity).

Module-1: Laplace Transform

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace's Transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of Periodic functions (statement only) and unit-step function – problems. Inverse Laplace transforms definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) problems. Laplace transforms of derivatives, solution of differential equations. **(8 Hours)**

Self-study: Solution of simultaneous first-order differential equations.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2: Fourier Series

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's condition. Fourier series of periodic functions with period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis. **(8 Hours)**

Self-study: Convergence of series by D'Alembert's Ratio test and, Cauchy'sroot test.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Infinite Fourier Transforms and Z-Transforms

Infinite Fourier transforms definition, Fourier sine and cosine transforms. Inverse Fourier transforms, Inverse Fourier cosine and sine transforms. Problems.

Difference equations, z-transform-definition, Standard z-transforms, Damping and shifting rules, Problems. Inverse z-transform and applications to solve difference equations. **(8 Hours)**

Self Study: Initial value and final value theorems, problems.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Numerical Solution of Partial Differential Equations

Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank-Nicholson method, Solution of the Wave equation. Problems.

(8 Hours)

Self Study: Solution of Poisson equations using standard five-point formula.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Numerical Solution of Second-Order ODEs and Calculus of Variations

Second-order differential equations - Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).

Calculus of Variations: Functionals, Euler's equation, Problems on extremals of functional. Geodesics on a plane, Variational problems. **(8 Hours)**

Self Study: Hanging chain problem

(RBT Levels: L1, L2 and L3)

Course outcomes: After successfully completing the course, the students will be able :

- To solve ordinary differential equations using Laplace transform.
- Demonstrate the Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- To use Fourier transforms to analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations
- To solve mathematical models represented by initial or boundary value problems involving partial differential equations
- Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

First test at the end of 5th week of the semester

Second test at the end of the 10th week of the semester

Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

First assignment at the end of 4th week of the semester

Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50

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Suggested Learning Resources:

Text Books:

1. **B.S.Grewal**:"HigherEngineeringMathematics",Khanna publishers,44th Ed.2018
2. **E.Kreyszig**:"AdvancedEngineeringMathematics",JohnWiley&Sons,10th Ed.(Reprint),2016.

Reference Books

1. **V.Ramana:**"HigherEngineeringMathematics"McGraw-HillEducation,11th Ed.
2. **SrimantaPal&SubodhC.Bhunia:**"EngineeringMathematics"OxfordUniversityPress,3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co.Newyork, Latested.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education(India) Pvt. Ltd2015.
6. **H.K.DassandEr.RajnishVerma:**"HigherEngineeringMathematics"S.ChandPublication(2014).
7. **JamesStewart:"**Calculus"Cengagepublications,7th edition,4th Reprint2019.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- http://www.bookstreet.in.
- VTU e-ShikshanaProgram
- VTU EDUSATProgram

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars

Semester - III

MANUFACTURING PROCESSES (IPCC)			
Course Code	**21MR32**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
* One additional hour may be considered wherever required			

Course objectives:

- To acquaint with the basic knowledge on fundamentals of casting processes.
- To impart knowledge of various joining processes used in manufacturing.
- To know the various subtractive machining processes in industries.
- To understand different advanced machining processes.
- To study various metal forming processes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

CASTING PROCESS

Sand casting: pattern and core making- materials, allowances, types, moulding process - sand properties, melting furnaces – pit furnace and electric furnaces. Melting and founding of cast iron, degasification, design of casting and risering, pouring and feeding of casting,

Special casting processes: Shell, investment, die casting – pressure and gravity types – squeeze casting - defects in casting - Plastic moulding – injection and blow moulding.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

WELDING PROCESS

Definition, Principles, classification, application, advantages & limitations of welding.

Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).

Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding.

Gas welding: Principle, oxy-Acetylene welding, oxyhydrogen welding, air-acetylene welding, Gas cutting,

Defects and Inspection of welded joints.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

27.09.2022

MACHINING PROCESSES **Lathe**: *Review of- working principle, classification, specification, different operations on a lathe.* Lathe accessories and tool holders, machining time and power required for cutting. Capstan lathe and Turret lathe, Introduction to CNC lathe, parts and functions. **Drilling and boring** - classification, specification and constructional features of drilling and boring machines, machining time calculation **Milling** - classification, principle, parts & specification of milling machines, milling process-cutters, indexing **Shaping, Planing and Slotting machines-** constructional features and machining operations

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4	**8 HOURS**
ADVANCED MACHINING PROCESSES Abrasive Jet Machining, Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, Electrochemical machining, Laser Beam Machining, Plasma Arc Machining, Electron Beam Machining. **FINISHING PROCESS** **Surface finishing processes**: Grinding, Lapping, honing and super finishing process –overview of machines used, grinding wheels and specification, selection of grinding wheels, ship hull finishing.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE 5	**8 HOURS**
METAL FORMING PROCESS **Hot and cold working processes** – Rolling, forging, drawing and extrusion processes, bending, hot spinning, shearing, tube and wire drawing, cold forming, shot peening. **Sheet metal working** – Blanking, piercing, punching, trimming, Bending – types of dies – progressive, compound and combination dies. High-energy rate forming processes. **Additive Manufacturing**: Introduction to 3D-printing and rapid prototyping	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.No.	Experiments
1	Study the effect of the clay and moisture content on sand mould properties
2	Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
3	To determine permeability number of green sand, core sand and raw sand.
4	To determine AFS fineness no. and distribution coefficient of given sand sample.
5	Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats
6	Preparing forged models involving upsetting, drawing and bending operations
7	One Job on Lathe machine with simple operations (turning, facing, Thread cutting and tapering) on low carbon steel and/or heat-treated low carbon steel, and Demonstration of tungsten carbide cutting tool inserts.
8	Operations and One Job each on shaping/milling machine
9	Simple operations and One Job each on/ the drilling and grinding machine.
10	**Demonstration** operation on anyone advanced machining process
11	**Demonstration** Experimentation of simple programming of CNC machine operations.
12	**Demonstration** Experiment on using Drill Jig & turning and grinding fixtures.

27.09.2022

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Understand the concepts of metal casting, forming, welding and metal cutting.(L2)

CO2: Assess, compare and select appropriate manufacturing Processes. (L2)

CO3: Apply principles of casting, forming, welding, and metal cutting to specific applications. (L3)

CO4: Adapt the principles of manufacturing Processes to develop the mechanical components.(L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books:

1. P N Rao, Manufacturing Technology, Vol. 1 – Foundry, Forming, and Welding, 5th Edition, 2019, McGraw Hill Education (India) Private Limited, ISBN-13: 978-93-5316-050-0.
2. P N Rao, Manufacturing Technology, Vol. 2 Metal Cutting and Machine Tools, 4th Edition,2019, McGraw Hill Education(India) Pvt. Limited,ISBN-13: 978-93-5316-052-4.
3. Hajra Choudhary, S. K. and Hajra Choudhary, A. K., "Elements of Workshop Technology", Vol I (10th edition) , Media Promoters & Publishers, Bombay 2007
4. Hajra Choudhary, S. K. and Hajra Choudhary, A. K., "Elements of Manufacturing Technology" Vol II (15th edition), Media Promoters & Publishers, Bombay 2010

Additional References:

1. Chapman W.A.J., "Workshop Technology", Vol. II, Arnold Publishers,1972
2. H.M.T., "Production Technology", Tata McGraw-Hill, New Delhi, 2000.
3. Serope Kalpakjian , Steven,R. Schmid, "Manufacturing Engineering and Technology,"4th Ed. Pearson, 2011
4. Roy A Lindberg, "Process and Materials of Manufacturing", Pearson Edu 4th Ed. 2006
5. Mikell P. Groover, (2019), Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Publications.

Web links and Video Lectures (e-Resources):

1. Manufacturing Processes II, IIT Kharagpur, Prof. A.B. Chattopadhyay, Prof. A.K. Chattopadhyay, Prof. S. Paul , http://nptel.ac.in/courses/112105127
2. V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: http://nptel.ac.in/courses/112104028/.
3. Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006. (https://books.google.co.in/books?id=NOotk64Grx0C&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false)
4. Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006.
5. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, https://nptel.ac.in/courses/112/105/112105126/
6. U. S. Dixit, Mechanics of Machining, NPTEL Course Department of Mechanical Engineering Guwahati, Link: http://nptel.ac.in/courses/112103248/.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

1. Case study/visit on Metal Casting: Design pattern/core for a given component drawing and develop a sand mould with optimum gating and riser system for ferrous and non-ferrous materials. Melting and casting, inspection for macroscopic casting defects.
2. Case study/visit on Welding: TIG and MIG welding processes – design weld joints – welding practice –weld quality inspection.
3. Case study/visit on Metal Forming: Press working operation – hydraulic and mechanical press -load calculation: blanking, bending and drawing operations – sheet metal layout design.
4. Visit any one machining centre or machining industry /Case study on process parameter influence on any one advanced machining process and hybrid machining process.

27.09.2022

Semester - III

MATERIAL SCIENCE (IPCC)			
Course Code	**21MR33**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
* One additional hour may be considered wherever required			

Course objectives:

- To understand the structure and behaviour of engineering materials.
- To explore the mechanical properties of metals and their alloys
- To impart knowledge of formation of alloys
- To impart knowledge of selections of different materials for various applications.
- To understand modifications of material properties by heat treatment processes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

Structure of Materials

Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding

Geometrical Crystallography: Symmetry elements: the operation of rotation, Proper and Improper rotation axes, Screw axes, Glide planes

Crystal Structure: Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, packing of atoms and packing fraction, Classification and Coordination of voids, Bragg's Law

Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects,

2-D and 3D-defects, Concept of free volume in amorphous solids.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Mechanical Behaviour: Stress-strain diagrams showing ductile and brittle behaviour of materials, Engineering stress and true strains, Linear and non- linear elastic behaviour and properties, Mechanical properties in plastic range: Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness, Hardness-testing methods. Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals.

Failure of Materials: Fracture –ductile & brittle fracture, fracture mechanism

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, S-N diagram, fatigue testing.

Creep: Description, mechanism of creep, creep properties, Stress relaxation.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

27.09.2022

Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume-Rothery rules) ,Binary phase diagrams: Eutectic and Eutectoid systems, Lever rule, Intermediate phases, Gibbs phase rule, Effect of non-equilibrium cooling **Iron-Carbon (Cementite) diagram**: description of phases, Effect of common alloying elements in steel, Common alloy steels, Stainless steel, Tool steel, Specifications of steels. **Solidification**: Mechanism of solidification, Homogeneous and Heterogeneous nucleation, Crystal growth, cast metal structures, Solidification of Steels and Cast irons. Numerical on Lever rule.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE-4	**8 HOURS**
Ferrous and non-ferrous materials Properties, Composition and uses of Grey cast iron, malleable iron, SG iron and steel Copper alloys-brassesand bronzes. Aluminum alloys-Al-Cu, Al-Si,Al-Zn alloys. Titanium alloys, Properties and applications of materials used in machinery on board ships **Properties and parameters considered in the fabrication and repair of systems and components** – Materials under load, vibration, self-secured joints, permanent joints, bonding plastics, adhesives and bonding, pipe work. **EnvironmentalDegradation of Materials**: Different forms of environmental degradation, forms of corrosion- Galvanic, Intergranular, pitting, stress related corrosion. Corrosion control- Materials selection, protective coating.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE 5	**8 HOURS**
Heat Treatment: Time-Temperature Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Heat treatment: Annealing- Types of annealing, Normalizing, Hardening, Tempering, Concept of Hardenability, Factors affecting hardenability, Martempering, Austempering **Surface hardening methods**: Carburizing, Cyaniding, Nitriding, Flame hardening and Induction hardening, Age hardening of aluminium-copper alloys.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.No.	Experiments
1	Specimen preparation for macro and micro structural examinations and study the macrostructure and microstructure of a sample metal/ alloys
2	To study the crystal structure of a given Cast Iron, Mild steel, Aluminium and Copper/Brass specimens and study the crystal imperfections in a given Cast Iron, Mild steel and Aluminium specimens.
3	Study the heat treatment processes (Hardening and tempering) of steel/Aluminium specimens.
4	To determine the hardness values of Mild Steel/ Aluminium by Rockwell hardness/Vickers Hardness.
5	To determine the hardness values of Copper/ Brass by Brinell's Hardness testing machine.
6	To determine the tensile strength, modulus of elasticity, yield stress, % of elongation and % of reduction in area of Cast Iron, Mild Steel/Brass/ Aluminium and to observe the necking.
7	Shear compression and Bending tests of steel, aluminum and cast iron specimens using Universal Testing Machine
8	Torsion Test on steel bar.
9	Izod and Charpy Tests on Mild steel and C.I Specimen.
10	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing.

11	To study of microstructure of welding Mild Steel components and Heat affected zone (HAZ) macro and micro examinations (Demonstration)
12	Fatigue Test (demonstration)
13	Study the chemical corrosion and its protection.(Demonstration)
14	Computer Aided Selection of Materials: Application of GRANTA Edupack for material selection: Case studies based on material properties. (Demonstration)

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Understand behaviour of various materials with respect to crystal structure, mechanical behaviour, phase transformation and corrosion (L2)

CO2: Identify suitable materials for specific engineering application (L3)

CO3: Investigate mechanical properties and microstructures of different materials (L4)

CO4: Analyze materials, composition and their phase transformation (L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books:

1. William D Callister, Material Science and Engineering, , 6th Edition, 1997, John Wiley and Sons, ISBN 9812-53-052-5
2. Raghavan, V. Materials Science and Engineering: A First course, 6th edition, PHI Learning, 2015.
3. Smith, W.F., Hashemi, J. & Prakash, R. "Materials Science and Engineering". Tata McGraw Hill Education Pvt. Ltd., 2014.

Additional References:

1. O. P Khanna, A text book of Material Science and Metallurgy, Dhanpat Rai Publishers, 2010
2. Ashby, M.F., Materials Selection in Mechanical Design, 4th Edition, Butterworth- Heinemann, 2010
3. Avner, S.H., Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Education, 2017

Web links and Video Lectures (e-Resources):

1. Bhattacharya,B., *Materials Selection and Design,* NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, http://nptel.ac.in/courses/112104122/
2. Prasad, R., Introduction to Materials Science and Engineering, NPTEL Course Material, Department of Materials Science and Engineering, Indian Institute of Technology Delhi,
3. http://nptel.ac.in/courses/113102080/
4. Subramaniam, A., Structure of Materials, NPTEL Course Material, Department of Material Science and Engineering, Indian Institute of Technology Kanpur,https://nptel.ac.in/courses/113104014/
5. Schuh, C., 3.40J Physical Metallurgy. Fall 2009. Massachusetts Institute of Technology: MIT Open Course Ware, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.
6. Ghosh, R.N., Principles of Physical Metallurgy, IIT Kharagpur, http://nptel.ac.in/syllabus/113105024/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

1. Case study/visit on Metal Casting: Design pattern/core for a given component drawing and develop a sand mould with optimum gating and riser system for ferrous and non-ferrous materials. Melting and casting, inspection for macroscopic casting defects.
2. Case study/visit on Welding: TIG and MIG welding processes – design weld joints – welding practice –weld quality inspection.
3. Case study/visit on Metal Forming: Press working operation – hydraulic and mechanical press -load calculation: blanking, bending and drawing operations – sheet metal layout design.
4. Visit any one machining center or machining industry /Case study on process parameter influence on any one advanced machining process and hybrid machining process.

27.09.2022

Semester-III

THERMODYNAMICS			
Course Code	**21MR34**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Understand various forms of energy - heat transfer and work
- State and apply the basic laws of thermodynamics viz: zeroth law, first law and second law.
- Interpret the behaviour of pure substances and its application in practical problems.
- Study the behaviour of Ideal and real gases and evaluate their thermodynamic properties
- Analyse the air standard, gas and vapour power cycles used in prime movers.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction and Review of fundamental concepts (**Only for Self-study & CIE**)*: Thermodynamic definition and scope, Microscopic and Macroscopic approaches, Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium*

Zeroth law of thermodynamics. Temperature; scales, thermometry, Importance of temperature measuring instruments. Design of Thermometers.

Work and Heat: Thermodynamic definition of work; examples, sign convention, Displacement work, Heat; definition, units and sign convention, Expressions for displacement work and heat in various processes through p-v diagrams. Shaft work, Electrical work.

First Law of Thermodynamics: Statement of the first law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, Steady Flow Energy Equation (SFEE) and engineering applications.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Second Law of Thermodynamics and Entropy: Limitations of first law of thermodynamics. Devices converting heat to work; (a) In a thermodynamic cycle, (b) In a mechanical cycle. Thermal reservoir, direct heat engine; schematic representation and efficiency, Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Refrigerators, and heat pumps, COP, Clausius statement of Second law of Thermodynamics, Equivalence of statements, Carnot cycle, Carnot theorem.

Entropy: Clausius inequality, Statement-proof, Entropy- definition, a property, change of entropy, Reversibility, causes of irreversibility, entropy as a quantitative test for irreversibility, entropy as a coordinate.

Available energy and Exergy: Available energy, Maximum work in a reversible process; useful work; Dead state; availability; Second law efficiency.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations

	3. Chalk and Talk.

MODULE-3	**8 HOURS**
Introduction and Review of Ideal and Real gases (Only for self-study and CIE)*: Ideal gas mixtures, Daltons' law of partial pressures, Amagats' law of additive volumes, Evaluation of properties of ideal gases. Real gases: introduction, Van-Der Waal's equation, Van-Der Waal's constants in terms of critical properties.* **Compressibility factor, compressibility chart and applications.** **Thermodynamic relations:** Maxwell's equations, TdS equation**.** Ratio of Heat capacities and Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation. **Combustion thermodynamics:** Theoretical (Stoichiometric) air for combustion of fuels, excess air, actual combustion. Exhaust gas analysis. A/F ratio, energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, adiabatic flame temperature, combustion efficiency.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4	**8 HOURS**
Pure Substances: P-T and P-V diagrams, triple point and critical points, sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat), Dryness fraction (quality) representation of various processes on T-S & H-S diagrams, measurement of quality. **Vapour Power Cycles:** Carnot vapour power cycle, simple Rankine cycle, actual vapour power cycles, ideal and practical regenerative Rankine cycles, open and closed feed water heaters, Reheat Rankine cycle and characteristics of an Ideal working fluid in vapour power cycles.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5	**8 HOURS**
Gas power cycles Ericson Cycle, Stirling Cycle, Air standard cycles-Otto cycle, Diesel cycle and Dual cycle, computation of thermal efficiency and mean effective pressure, comparison of Otto, Diesel & Dual cycles. **Gas turbine Cycles:** Introduction and classification of gas turbine, gas turbine (Brayton) cycle; description and thermal analysis, Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles, Jet Propulsion.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Describe the fundamental concepts and principles of engineering thermodynamics. (L1)

CO2: Understand the thermodynamic relations for different engineering applications. (L2)

CO3: Apply the governing laws of thermodynamics for different engineering applications. (L3)

CO4: Analyse the various thermodynamic processes, cycles and results. (L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Text Books

1. Basic and Applied Thermodynamics, P K Nag, 2nd Ed., Tata McGraw Hill Publications, 2017.
2. A textbook of Engineering Thermodynamics, R K Rajput, Fifth edition, Laxmi Publications, 2019.
3. Fundamentals of Thermodynamics, Claus Borgnakke and Richard E Sonntag, 8th edition, Wiley India Edition, 2020
4. Thermodynamics, An Engineering Approach, Yunus A Cenegal, Michael A Boles, and Mehmet Kanoglu, 9th Edition, Tata McGraw Hill publications, 2019

Reference Books

1. Engineering Thermodynamics, J B Jones and G A Hawkins, John Wiley and sons, 1986.
2. An Introduction to Thermodynamics, Y V C Rao, Wiley Eastern, 2003
3. Applications of Thermodynamics, Dr V Kadambi and Dr T R Seetharam, Wiley Publications, 2018.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112104113, (NPTEL-NOC: Basic Thermodynamics, IIT Kanpur)
- https://www.youtube.com/watch?v=9GMBpZZtjXM, (Lecture Series on Basic Thermodynamics, IIT Kharagpur
- https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
- https://www.youtube.com/watch?v=jkdMtmXo664&list=PL3zvA_WajfGAwLuULH-L0AG9fKDgplYne
- https://www.youtube.com/watch?v=1lk7XLOxtzs&list=PLkn3QISf55zy2Nlqr5F09oO2qcIwNNfrZ&index=3
- https://www.youtube.com/watch?v=Dy2UeVCSRYs&list=PL2_EyjPqHc10CTN7cHiM5xB2qD7BHUry7

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to Thermal power plants and submission of report
- Case study report and power point presentation on steam power plant.
- List of thermal energy devices at homes, hostels and college premises and applicable laws

27.09.2022

Semester-III

MACHINE DRAWING AND GD & T			
Course Code	**21MRL35**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	01	Exam Hours	03
* One additional hour may be considered wherever required			

Course objectives:

- To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings.
- To make drawings using orthographic projections and sectional views
- To impart knowledge of thread forms, fasteners, keys, joints, couplings and clutches.
- To understand and interpret drawings of machine components leading to preparation of assembly drawings manually and using CAD packages.

MODULE-1 (only for CIE) **1 SESSION**

Review of basic concepts of Engineering Visualization

Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.

MODULE-2 (only for CIE) **2 SESSIONS**

Sections of Simple and hollow solids: True shape of sections.

MODULE-3 (only for CIE) **3 SESSIONS**

Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread, Helicoil thread inserts

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly), simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, countersunk head screw, grub screw, Allen screw

Rivets

Keys: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key.

MODULE-4 **3 SESSIONS**

Assembly of Joints, couplings and clutches (with GD&T)using 2D environment

Joints: Like Cotter joint (socket and spigot), knuckle joint (pin joint).

Couplings: Like flanged coupling, universal coupling

Clutches: Like Single Plate clutch, cone clutches

MODULE-5 **5 SESSIONS**

Assembly of Machine Components (with GD&T) using 3D environment

(Part drawings shall be given)

1. **Bearings**
2. **Valves** (like flow control valves, Safety Valves, reducing valve)
3. **I.C. Engine components**
4. **Lifting devices**
5. **Machine/system components**(likecross head & guide shoe, bilge suction strainer, fuel control lever)
6. **Pumps**

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Interpret the Machining and surface finish symbols on the component drawings.

CO2: Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.

CO3: Illustrate various machine components through drawings

CO4: Create assembly drawings as per the conventions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks) and that for SEE minimum passing mark is 35% of the maximum marks (18 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing itby 50%.
- CIE component should comprise of
  - Continuous evaluation of Drawing work of students as and when the Modules are covered.
  - At least one closed book **Test** covering all the modules on the basis of below detailed weightage.
  - ***Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators***.

Module	**Max. Marks Weightage**	**Evaluation Weightage in marks**	
		Computer display & printout	**Preparatory sketching**
Module 1	10	05	05
Module 2	15	10	05
Module 3	25	20	05
Module 4	25	20	05
Module 5	25	25	00
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours**. Questions shall be set be worth of 3 hours**
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.
- ***SEE shall be conducted and evaluated for maximum marks 100. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.***
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule. **Questions are to be set preferably from Text Books.**
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: *To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.*
- One full question shall be set from Modules 3 and 4 as per the below tabled weightage details. ***However, the student may be awarded full marks, if he/she completes solution on computer display without sketch***.

Module	Max. Marks Weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module 4	40	30	10
Module 5	60	50	10
Total	**100**	**80**	**20**

Suggested Learning Resources:

Books:

- K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
- N D Bhatt , "Machine Drawing", Charotar Publishing House Pvt. Ltd.,50th Edition, ISBN-13: 978-9385039232, 2014
- H.G. Beck , "Reeds Vol 11: Engineering Drawing" (Reeds Marine Engineering and Technology Series), Reeds , 2019 ,1st edition.ISBN-10: 1472969855

Reference Books:

- Sadhu Singh, P. L. Sah, "Fundamentals of Machine Drawing", PHI Learning Pvt. Ltd, 2nd Edition, ISBN: 9788120346796, 2012
- Ajeet Singh, "MACHINE DRAWING", Tata McGraw-Hill Education, , ISBN: 9781259084607, 2012

27.09.2022

Semester-III

PROGRAMMING IN PYTHON (AEC)			
Course Code	**21MR381**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- Demonstrate the use of Anaconda or PyCharm IDE to create Python Applications
- Develop Python programming language to develop programs for solving real-world problems
- Utilize Object-Oriented Programming concepts in Python.
- Analyse the working of various documents like PDF, Word file

Sl.NO	Experiments
1	Develop a python program to find the best of two test average marks out of three test's marks accepted from the user.
2	Develop a python program to find the smallest and largest number in a list.
3	Develop a python program to arrange the numbers in ascending and descending order.
4	Develop a binary search program in python.
5	Develop a bubble sort program in python.
6	Develop a Python program to check whether a given number is palindrome or not and also count the number of occurrences of each digit in the input number.
7	Write a Python program that accepts a sentence and find the number of words, digits, uppercase letters and lowercase letters.
8	Write a Python program for pattern recognition with and without using regular expressions.
	Demonstration Experiments (For CIE)
9	Demonstrate python program to read the data from the spreadsheet and write the data in to the spreadsheet
10	Demonstration of reading, writing and organizing files.
11	Demonstration of the concepts of classes, methods, objects and inheritance
12	Demonstration of working with PDF and word files

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO 1. Demonstrate proficiency in handling loops and creation of functions.(L1,L2)

CO 2. Identify the methods to create and manipulate lists, tuples and dictionaries.(L2)

CO 3. Discover the commonly used operations involving regular expressions and file systems.(L3)

CO 4. Examine working of PDF and word file formats(L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.

- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3" 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf)
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Download pdf files from the above links)
3. Al Sweigart, "Automate the Boring Stuff with Python",1stEdition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)
4. Reema Thareja "Python Programming Using Problem Solving Approach" Oxford University Press.

27.09.2022

Semester-III

MICROCONTROLLERS (AEC)			
Course Code	**21MR382**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course Learning Objectives: This laboratory course enables students to

- Understand the basics of microcontroller and its applications.
- Have in-depth knowledge of 8051 assembly language programming.
- Understand controlling the devices using C programming.
- The concepts of I/O interfacing for developing real time embedded systems.

Sl.NO	Experiments
1	Studying the Architecture of 8051 microcontroller.
2	Studying basic instruction set.
3	Write an ALP to Data Transfer: Block Move, Exchange, Sorting, Finding largest element in an array.
4	Write an ALP for an Arithmetic Instructions like - Addition/subtraction, multiplication and division, square, Cube – (16 bits Arithmetic operations – bitaddressable).
5	Write an ALP for Boolean & Logical Instructions (Bitmanipulations).
6	Write an ALP for Counters.
	Demonstration Experiments (For CIE)
9	Demonstrate a simple toggle switch to 8051 and write an ALP to generate an interrupt which switches on an LED
10	To demonstrate interface a Stepper Motor to 8051 to rotate themotor.
11	Write a C program to (i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a terminal

Course outcomes (Course Skill Set): After studying this course, students will be able to:

CO1: Write Assembly language programs in 8051 for solving simple problems that manipulate input data using different instructions of 8051.

CO2: Interface different input and output devices to 8051 and control them using Assembly language programs.

CO3: Interface the serial devices to 8051 and do the serial transfer using C programming.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.

- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Text Books:

1. "The 8051 Microcontroller and Embedded Systems – using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
2. "The 8051 Microcontroller", Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

Reference Books:

1 "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.
2. "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005.

27.09.2022

Semester-III

CHARTERING (AEC)			
Course Code	**21MR383**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Understands the basics of cargoes and trade routes
- Explore the basics of freight Markets
- Understand the charter contracts

Teaching-Teaching-Learning Process (General Instructions)

These are sample Strategies,which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it

Module-1	
CARGOES AND TRADE ROUTES: ship types required for different cargoes and trade routes,nature, characteristics, hazards and stowage requirements of the four main dry commodities, namely Coal, Ore, Grain and Fertilizers. Angle of repose, ventilation and prevention of stowage hazards.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-2	
FREIGHT MARKETS: role of the different market practitioners; Charterers, Shipowners, Operators;dry cargo chartering market and the relative importance of the major market centres,role of the Broker and its relationship to the principals as an agent;INCOTERMS.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-3	
CONTRACTS: basic format and purpose and content of those main clauses common to all Charter Party forms; use of standard forms of voyage and time charter parties.;Voylay Rules 1993 and FONASBA Time Charter Interpretation Code 2000; responsibilities and liabilities of owners, charterers and brokers which arise under the charter party.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-4	
CHARTERING MARKET PRACTICE: Procedure of negotiations including cargo circulars, indications, and firm offers; customary abbreviations used during negotiation; process of offer, rejection and new offer (counter offer, accept/except) and acceptance; legal, tactical and ethical requirements of the market and the avoidance of conflicts between them.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-5
LAYTIME: importance of the clarity of notice of readiness clauses and be able to draft a concise clause; tendering a valid NOR and common problems relating to acceptance; nature of the information contained in the Statement of Facts and how the Laytime Statement is prepared; application of "Voylay Rules" with particular reference to Berth-v-Port charters and Weather Working Days.

27.09.2022

Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Course outcome (Course Skill Set)

At the end of the course the student will be able:

CO 1: list the basics chartering terms (L1)

CO 2: Describe applications of charter document(L2)

CO 3: Illustrate the use of a charter document (L3)

CO4: Apply the rules of charter parties for dry cargo vessels, writing of contracts, negotiating a charter, lay time calculation(L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Textbooks

1.Pagonis T., Pentheroudakis N., 2019, 'Chartering Manual by Practitioners', 1st Edition by Practitioner' Book Avenue, LLP, 27, Old Gloucester street, London WC1N 3AX, United Kingdom

2. Institute of Chartered Shipbrokers (2017). Dry Cargo Chartering, London: Witherbys

Reference Books:

1. Collins, N. (2000). The essential guide to chartering and the dry freight market. Clarkson Research Studies.

Web links and Video Lectures (e-Resources):

http://www.imo.org/en/Pages/Default.aspx https://lloydslist.maritimeintelligence.informa.com/ https://splash247.com/ https://www.bimco.org/ https://www.essdocs.com/ https://www.hellenicshippingnews.com/ https://www.ics.org.uk/ https://www.ics-shipping.org/ https://www.intertanko.com/ https://www.marineinsight.com/ https://www.maritime-executive.com/ https://www.maritimeinfo.org/

27.09.2022

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case studies on chartering negotiations.
- Presentations on changes in charter parties historically.

Semester 03 **Ability Enhancement Course III**

SPREAD SHEETS FOR ENGINEERS			
Course Code	21MR384	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	02

Course objectives:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Sl.NO	**Experiments**
1	**Charting:** Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	**Functions:** Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3	**Conditional Functions:** Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	**Regression Analysis:** Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.
5	**Iterative Solutions Using Excel:** Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.
6	**Matrix Operations Using Excel:** Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
7	**VBA User-Defined Functions (UDF):** The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure.
8	**VBA Subroutines or Macros:** Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.
	Demonstration Exercises
9	**Numerical Integration Using Excel:** The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.
10	.
11	**Differential Equations:** Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation
12	

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF

- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- McFedries PaulMicrosoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition
- E. Joseph Bill0, Excel@ for Scientists and Engineers Numerical Methods, WILEY-INTERSCIENCE A John Wiley & Sons, Inc., Publication, 2007
- https://onlinelibrary.wiley.com/doi/pdf/10.1002/0471461296.app4

27.09.2022

MARINE ENGINEERING

SEMESTER – IV

27.09.2022

27.09.2022

Semester - IV

MARINE ELECTRICAL TECHNOLOGY (IPCC)			
Course Code	**21MR42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
* One additional hour may be considered wherever required			

Course objectives:

- Theoretical and practical knowledge of the Electrical systems on Board ships.
- Study the electrical power distribution systems on board ships.
- Understanding of Motors and starters and their protection.
- Theoretical and practical understanding of lighting and battery systems.
- Understanding of the troubleshooting aspects of marine electrical systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

SHIPS' ELECTRICAL SYSTEMS - GENERATORS

Ships' Electrical System introduction - DC and AC. AC Generator (s), Rotating alternating current Generator-Construction and Cooling - Excitation Methods. Automatic Voltage Regulation - Generators in Parallel –synchronization. Generator Protection, Electromagnetic Compatibility, Emergency Generators and its location, SOLAS requirement for Emergency Generators.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

ELECTRICAL POWER DISTRIBUTION

Power Distribution Systems – 380V, 440 V & 240 V systems - Insulated and Earthed Neutral Systems - Switch boards and combination of switch and control gear - Circuit breakers and magnet switches . MSB Protection - Significance of Earth Faults - Transformers - Instrument Transformers - Shore Supply Connection -Non essential trips -Cables, types and requirement, Cable tracks (laying of cables), sealing when penetrates bulkheads Basic design criteria –load balance-short circuit calculation- Block, System, Line And Circuit Diagrams, Dangerous Zones – Zone 0, Zone 1 and Zone 2- Power Management systems , Dead man alarm system of engine room.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

MOTORS AND STARTERS

Introduction - Motor Construction – IP Protection /ratings – Induction Motor Operation - Control Equipment - Direct on-Line Starting - Reduced Voltage Starting - Speed Control - Motor Protection – Single Phase Motors – Maintenance.

Flame proof Enclosures (for light fittings and motors, etc on tankers) - Intrinsically Safety circuits - Increased Safety – Non-Sparking - Pressurized Enclosure - Special Protection - Certification and Identification(Markings).

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

ELECTRICAL SERVICES

Introduction - Ships' Lighting - Incandescent Lamps - Discharge Lamps - Voltage Effects on Lighting - Navigation and Signal Lights - Emergency Lighting - Maintenance of Lighting - Types of Batteries Battery Supplies. UPS ,Emergency generators and emergency Power for cargo ships, Internal Communication system -Talk back system, Sound powered telephone system- Automatic telephone installations, External communication system – ship shore communication system , Global Maritime Distress safety system

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE 5 **8 HOURS**

SAFETY AND MAINTENANCE OF ELECTRICAL SYSTEMS

General Electrical maintenance - Fault Finding, Generator maintenance , Overhauling of Motors when insulation is zero, Circuit Calculations – Electrical Diagrams - Electrical Safety - Electric Shock - Insulation Resistance - Circuit Testing - Insulation Testing - Continuity Testing – Multimeter - Diode Tests - Current Clamp meters - Live-line Testers – Maintenance of batteries and precautions to be taken for battery room

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.No.	Experiments
1	Load Characteristics of DC shunt and compound generator 1) Short shunt – cumulative and differential 2) Long shunt - cumulative and differential
2	Load test on a DC Motor- determination of speed – torque and HP – efficiency Characteristics
3	Swineburne's Test
4	Hopkinson's test
5	Field test on series motors
6	Retardation test – electrical braking method
7	Speed control of DC motor by armature voltage control and flux control
8	Ward leonard method of speed control of DC motor
9	Voltage regulation of an alternator by EMF and MMF Method
10	DEMO: Exercises in reading and drawing of electrical circuits with reference to ship electrical systems
11	DEMO: Exercises in Testing and troubleshooting of electric motors.
12	DEMO: Exercises in the use of Multimeter, Megger, Clamp meter, etc and their calibration.

27.09.2022

13	DEMO: Exercises in Power Wiring and earthing.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1:Describe Ships electrical systems, power distribution systems, motor construction, protection, lighting and battery services (L1)

CO2:Explain AC and DC generator systems, protection and circuit breakers, fire protection on electrical systems,working of communication systems, various testing equipment (L2)

CO3: Examine and compare electrical generation systems, distribution systems, motor protection, lighting , battery systems, safety and insulation. (L3)

CO4: Evaluate the performance of electrical machines and systems(L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books:

1. Elstan.A. Fernandez., "Marine Electrical Technology", 4th Edition, "Sterling Book House", Mumbai, 2004.
2. Edmund GR Kraallavers , "Advanced Elecrto-technology For Marine Engineers", 2nd Ed. Reeds Vol 07, Adlard Coles Nautical, London, 2010
3. H. D. McGeorge, "Marine Electrical Equipment and Practice, 2nd Edition, Elsevier Science, 2014

Additional References:

1. Surinder Pal Bali," Electrical Technology Machines and Measurements", Vol II, 1st Ed. Pearson, 2013
2. Surinder Pal Bali," Electrical Technology Machines and Measurements", Vol.I, 1st Ed. Pearson, 2013

Web links and Video Lectures (e-Resources):

1: https://ems-iitr.vlabs.ac.in/List%20of%20experiments.html (Electrical Machines virtual Lab)
2:https://nptel.ac.in/courses/108105155 (NPTEL-NOC: Electrical Machines - I, IIT Kharagpur)
3: https://www.youtube.com/watch?v=5Z-pHEJuL-U (VideoTel Lecture)

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

1: Conduct interactive sessions on reading of ship electrical diagrams.
2: Conduct Case studies on fires due to failure of electrical systems.
3: Group discussions on SOLAS Regulations Chapter II-1.

27.09.2022

Semester - IV

FLUID MECHANICS & MACHINERY (IPCC)			
Course Code	**21MR43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
* One additional hour may be considered wherever required			

Course objectives:

- Acquire a basic understanding of properties of fluids and the measurement of pressure and fluid kinematics.
- Acquire a basic understanding of fundamentals fluid dynamics, and Benoulli's equation and flow meters.
- Acquire the basic concepts of flow through pipes and flow over bodies
- Understand the basic concepts of energy conversion in turbo machines.
- Analyse power producing and power absorbing turbo machines.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

Introduction*: Definition and properties, types of fluids, pressure at a point in static fluid, variation of pressure, Pascals Law, (To be reviewed in class but not for examination)*

Pressure- Absolute, gauge, vacuum, pressure measurement by manometers and gauges, hydrostatic pressure on plane submerged bodies. Buoyancy and metacentre, Stability of submerged bodies

Fluid Kinematics: Velocity of fluid particle, types of fluid flow, streamlines, pathlines and streaklines, continuity equation, acceleration of fluid particle, strain rate, vorticity, stream function, potential function, Circulation, Reynolds transport theorem

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Fluid Dynamics: Introduction, Forces acting on fluid in motion, Linear momentum equation, Impact of jets, Moment of momentum equation, Euler's equation of motion along a streamline

Bernoulli's equation – assumptions and limitations. Introduction to Navier Stokes equation, Venturi meters, orifice meters, rectangular and triangular notches, pitot tubes, Rotameter, electromagnetic flow meter.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

27.09.2022

Laminar and turbulent flow: Dimensionless numbers, Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation, loss of head due to friction in viscous flow **Turbulence:** characteristics of turbulent flow, laminar turbulent transition, major and minor losses **Flow over bodies:** Development of boundary layer, Lift and Drag, Flow around circular cylinders	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE-4	**8 HOURS**
Introduction to Turbo machines: Classification of Turbomachines, Basic constructional details, Euler's equations for a Turbo machine, Impulse & Reaction machine, Axial flow and radial flow machines, utilization factor, degree of reaction & efficiencies of Turbo machines **Hydraulic Turbines**: Classification of hydraulic turbines, Principle of working, velocity triangles - Pelton wheel - Francis turbine- Kaplan turbine, design parameters and numerical problems, Draft tubes	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE 5	**8 HOURS**
Centrifugal and Axial flow Pumps: Main Parts of centrifugal pump, basic terms and definitions, velocity triangles, work done, minimum speed for starting centrifugal pump, Classifications- Performance characteristics of centrifugal pumps, Cavitation in pumps and NPSH, multistage pumps. Axial flow Pumps – characteristics – constructional details, efficiencies.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.No.	Experiments
1	Determine the viscosity of oil using Redwood viscometer and Say-bolt viscometer.
2	Measurement of pressure using different Manometers for high and low pressure measurements (manometers using different manometric fluids).
3	Working principle of different flow meters and their calibration (orifice plate, Venturi meter, turbine, Rota meter, electromagnetic flow meter)
4	Working principle of different flow meters for open channel and their calibration
5	Determination of head loss in pipes and pipe fittings having different diameters, different materials and different roughness
6	Effect of change in cross section and application of the Bernoulli equation
7	Impact of jet on flat and curved plates
8	Performance test on Pelton turbine and draw its main and operating characteristics.
9	Performance test on Francis turbine and draw its main and operating characteristics.
10	Performance test on Kaplan turbine and draw its main and operating characteristics.
11	Performance test on single / multi-stage centrifugal pump.
12	Reynolds apparatus to measure critical Reynolds number for pipe flows (Demonstration)
13	Determination of drag and lift coefficient of standard objects using wind tunnel (Demonstration)

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:

CO1: Describe the fundamental concepts and principles of fluid mechanics and machinery. (L1)
CO2: Understand the fluid dynamics relations for different engineering applications. (L2)
CO3: Apply the governing laws of fluid mechanics for different engineering applications. (L3)

CO4: Analyse the various fluid flow processes and turbomachines. (L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books:

1. Fox, R. W., Pitchard,P. J.,and McDonald, A. T., (2010), Introduction to Fluid Mechanics, 7thEdition, John Wiley & Sons Inc.
2. Cimbala, J.M., Cengel, Y. A. (2010),Fluid Mechanics: Fundamentals and Applications, McGraw-Hill
3. Frank M White., (2016), Fluid Mechanics, 8thEdition , McGraw-Hill
4. V. Kadambi and Manohar Prasad (2008), An Introduction to Energy Conversion, Volume III, Turbo machinery, New Age International Publishers, reprint

Additional References:

1. A textbook of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers
2. Fundamentals of Fluid Mechanics, Munson, Young, Okiishi & Hebsch, John Wiley Publicationss, 7th Edition

Web links and Video Lectures (e-Resources):

1. Fluid Mechanics, IIT Kanpur,Prof. Gautam Biswas, Prof. Suman Chakraborty, https://nptel.ac.in/courses/112104118
2. Fluid Mechanics, IIT Guwahati, Dr. Subhashisa Dutta, https://nptel.ac.in/courses/105103192
3. Fluid Machines, IIT Kharagpur, Prof. Suman Chakraborty, https://nptel.ac.in/courses/112105206
4. Fluid Machines, IIT Kharagpur, Prof. Sankar Kumar Som, https://onlinecourses.nptel.ac.in/noc19_me55

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

1. Visit to thermal hydel power plant and make a report
2. Visit ports and make a study report on hydraulic systems used on board ships.

27.09.2022

Semester-IV

BASIC SHIP KNOWLEDGE AND WATCH KEEPING			
Course Code	**21MR44**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To provide basic knowledge of ship layout and terms related to ships
- To provide knowledge of various types of vessels and the cargo they carry
- To provide understanding on manning , Certificate of Competence
- To provide basic knowledge on ship operation and watch keeping in the engine room
- To provide knowledge on handling emergencies and survival equipments

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction to ship layout

Sections and parts of a ship: Longitudinal view of a general cargo ship, Mid ship section. Ships parts-Hull, Deck, Bottom, double bottom, collision bulkhead, aft bulkhead-E/R- cargo Holds-ForeCastle deck-poop deck- deck houses–Accommodation, main engine-intermediate shaft-propeller shaft, strain tube-aft seal and fwd seal – propeller – stern tube and stern Cooling Tank- aft peak tank, and rudder stock-rudder- Double bottom tanks-cofferdam-fore peak tank , Chain locker

Deck arrangements – Air vents, sounding pipes , Ventilators , bunker manifold, masts, CO_2 room and paint store and cargo holds – lower hold, tween deck.

Accommodation arrangements – Wheel house, Galley , Mess rooms , Cargo control room, stores

Engine room - Main engine, Generator diesel engine and auxiliaries, cold chambers- meat room, vegetable room and dry provision room.

Deck machinery - Layout of Aft and forward Mooring winches, Windlass, Anchor chain, cranes- electric , hydraulic Marking s on the ship – stern, bow and accommodation front

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Types of ships and its operations:

Unit Cargo – Container vessel, RORO, Refrigerated ships, cattle ship and heavy cargo ship

Bulk Cargo –Bulk carrier, ore carrier, Coal carrier and Grain carrier

Liquid cargo- Crude carrier - product tanker , Chemical tanker, LPG Tanker and LNG tanker

Offshore vessels – Drillships, Anchor handling Tugs, Platform supply vessels , Accommodation vessels

Dredgers -

Port vessels - Tugs and Pilot vessels

Operation of ocean going vessels –difference between coastal trade and foreign trade, difference between short and unrestricted international voyages, inspections of vessels in Port , Flag state and port control Difference between Flag state control

Arrival and departure procedures for ships with familiarization of various notices and action to be taken

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Manning of ships, Certificate of competence

Manning - Deck, Engine and catering depts., officers and crew. Safe manning of a vessel. Certificate of competence, **Requirements of COC**- Class IV, Class II and Class I as per DG shipping, Introduction to DG and MMD and their roles- Difference between Flag state and port state control / inspection. Reasons for detention of vessels

Introduction to IMO, STCW and its role – (only Chapter III), pre sea courses, Post sea courses, specialized vessels courses.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk

MODULE-4 **8 HOURS**

Operation of vessels and Watch keeping

Vessel in port for loading / unloading or both. Draft marks, trim, heel, Loading limit, load line marks on the ships side. Definition of voyage, international and short international voyage. Coastal ships, Near Coastal vessels. Anchorage, Pilot age and berthing of vessels Definition of watch, watch keeping principles, Watch arrangements, - Sea watch, Port watch and anchor watch.

Requirements of watch keeping, Fitness for duty, Rest hours, Alcohol limit, -COC, Engine room Log book and movement book, difference of ships log book and engine log book. Duties of Engineer officer in sea watch and in port.

Preparation for main diesel engine for a sea voyage. Bow and stern Thrusters Various systems that are required for operation of the main engine.

Dry docks – purpose of dry docking of the vessel , Floating dry dock

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Shipboard Emergencies

Fire -Types of Fire , Fire in Engine room, Portable extinguishers and types, Fixed firefighting systems , Fire main, Hoses and Hydrants Fire Pumps in E/R, Emergency fire pump, CO 2 System . Reasons for large fire in Engine room, Cargo hold, Paint store fire, accommodation fire, Galley exhaust fire and deep fat fryer fire and how same extinguished - Towing arrangement of cargo vessel and on a tanker.

Grounding – Astern double ring – To check tank soundings, precautions, Towing of a vessel and arrangements

Collision – in congested water

Flooding of engine room – emergency bilge suction

Power failure – Emergency Generator.

Introduction to SOLAS and SOLAS requirement for emergency power for cargo ships

Introduction to life saving equipment and survival craft arrangements – lifeboats, life rafts

Man overboard - rescue boats

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Define part of a ship, types of vessels and watch keeping routines (L1)

CO2: Classify ship structures, vessel types, ranks; voyages and emergencies (L2)

CO3: Explain deck and engine room arrangements, ship operations, manning, COC and emergencies (L2)

CO4: Identify ship layouts, vessel types; requirements of competence and apply principles of seamanship to specific

emergency scenarios. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. J. K. Dhar, Basic Marine Engineering, 11th Edition,2019,G-Maritime Publications , ISBN:GMPISBN01.
2. David House, Seamanship Techniques: Shipboard and Marine Operations ,5th Edition ,2018, Routledge ,ISBN-13 978-1138676114
3. Paul A Russell, Leslie Jackson, Thomas D. Morton, Reeds Vol. 8: General Engineering Knowledge,6th Edition,2018,Bloomsbury, ISBN9781472952714

Reference Books:

1. SOLAS Consolidated Edition 2020, International Maritime Organization; 7th ed.,2020,ISBN-13 : 978-9280116908
2. MARPOL Consolidated Edition 2018 (Vol A & B), Bhandarkar Publications; 2016th edition, 2018,ASIN : B071DFXF3H

Web links and Video Lectures (e-Resources):

27.09.2022

- https://www.imo.org/en/KnowledgeCentre/ConferencesMeetings/Pages/SOLAS.aspx
- https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx
- https://www.youtube.com/watch?v=Q7Espb0afMw
- https://www.dieselduck.info/index.html
- https://www.youtube.com/channel/UClH53bXYykb-erNZ_kVBtOQ

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case study on SOLAS and MARPOL
- Ship models to be made in groups to study various ship structures
- Presentations on various shipping accidents and their case studies.

27.09.2022

Semester-IV

MECHANICAL MEASUREMENTS AND METROLOGY LABORATORY			
Course Code	**21MRL46**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2*-0	SEE Marks	50
Credits	01	Exam Hours	03
**** Additional one hour may be considered for instructions, if required***			

Course objectives:

Students will be able

- To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
- To illustrate the use of various measuring tools & measuring techniques.
- To understand calibration techniques of various measuring devices.

Sl.NO	Experiments
1	Study of instruments for Linear measurement and angular measurements: Slip gauges- Measurement of angle- sine bar, Sine center, Angle gauges, Optical instruments for angular measurements.
2	Study of Autocollimator-Applications for measuring straightness and squareness.
3	Study of different Comparators and calibration of Dial indicator, Electrical comparators, LVDT, Pneumatic comparators
4	Study of Terminology of screw threads and Measurement of major diameter, Minor diameter, Pitch, Angle and Effective diameter of screw threads by 2- wire and 3-wire methods
5	Gear tooth measurement using Gear tooth Vernier and Parkinson Gear Tester
6	Various parameter measurement using computerized profile projector
7	Surface topology measurement using Surface Roughness Tester
8	Calibration of Pressure gauge, Thermocouple and Load cell
9	Determination of modulus of elasticity and modulus of rigidity of a mild steel specimen using strain gauges
10	Calibration of Micrometer and Vernier caliper using slip gauges
11	Circularity measurement using Electronic and Mechanical comparator
12	Demonstration of Measurement using Coordinate Measuring Machine (CMM) / Laser Scanner
13	Choose any product used in the day to day life based on his/her choice, prepare a measurement plan and implement the measurement with existing tools

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Calibrate measuring instruments

CO2: Measure linear, angular dimensions and thread & gear tooth parameters using measuring instruments

CO3: Measure force, pressure, temperature and strain using indirect measuring methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Engineering Metrology and Measurements, N.V.Raghavendra and L. Krishnamurthy, Oxford University Press
2. Mechanical Measurements, Beckwith, Marangoni, Lienhard, Pearson Education. ISBN-13:978-9332518520
3. Mechanical Measurements and Instrumentation, R K Rajput, S.K. Kataria & Sons publication, ISBN-13: 978-9350142851
4. Engineering Metrology by R K Jain, Khanna Publication, ISBN-13: 978-8174091536

27.09.2022

Semester-IV

INTERNET OF THINGS (AEC)			
Course Code	**21MR481**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	01

Course objectives:

- Demonstrate installation of IDE to create IoT application
- Illustrate diverse methods of deploying smart objects and connect them to networks.
- Develop Python programming language to develop programs for solving real-world problems
- Analyse sensor technologies for sensing real world entities

Sl.NO	Experiments
1	Design a smart bin using IoT with Arduino / Raspberry Pi
2	Design water level monitoring system using IoT with Arduino / Raspberry Pi
3	Design temperature monitoring system using IoT with Arduino / Raspberry Pi
4	Design car parking management system using IoT with Arduino / Raspberry Pi
5	Design automated pet feeder using IoT with Arduino / Raspberry Pi
6	Design smart agriculture system using IoT with Arduino / Raspberry Pi
7	Design smart street light monitoring system using IoT with Arduino / Raspberry Pi
8	Design smart anti-theft system using IoT with Arduino / Raspberry Pi
	Demonstration Experiments (For CIE)
9	Demonstrate Alexa based smart home monitoring system using IoT
10	Demonstration ECG monitoring using IoT
11	Demonstration home automation system using IoT
12	Demonstration of face recognition bot using IoT

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Understand basic concepts of IoT, Arduino / Raspberry Pi (L1)

CO2: Build application oriented projects using IoT (L3)

CO3: Develop algorithm to solve real time problems (L3)

CO4: Design circuit to interface sensors and controller (L5)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics

suggested in Annexure-II of Regulation book

- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things'', 1 stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Srinivasa K G, “Internet of Things”,CENGAGE Learning India, 2017

Reference Books:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1 st Edition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, “Internet of Things: Architecture and Design Principles”, 1 st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

27.09.2022

Semester-IV

PLC AND SCADA (AEC)			
Course Code	**21MR482**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- To explain the history of Industrial automation.
- To describe the hardware components and field instruments.
- To describe PLC's and its architecture.
- To explain types of PLC models.
- To explain the ladder programming fundamentals

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it

Module-1	
Introduction about industrial automation : Introduction about industrial automation, History of industrial automation, Need of automations in industries, Example for industrial automation, Automation control circuit and power circuit, Control system in Industry	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration
Module-2	
Field Instruments: Types and working of field devices, Automation using relays and field devices, Examples for relays and field devices, Logical functions done by relays and field devices.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration
Module-3	
Introduction about Programmable Logic Controller: History of PLC , Architecture of PLC, CPU IO Modules ,Power Supply and Communications, Input and Output Devices, Need of PLC for Industrial Automation.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration
Module-4	
Types of PLC Models: Introduction about PLC Programming, Types of Programming Languages, Introduction about PLC Programming software.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration
Module-5	
Ladder programming fundamentals: Ladder logic diagram , Structure of program, Procedure for creating ladder diagram, Logical function done by ladder program in software.	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

27.09.2022

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Discuss history of PLC and describe the hardware components of PLC: I/O modules, CPU, memory devices,other support devices, operating modes and PLC programming.

CO2: Describe industrial automation, field devices, working of PLC's, Structure of a PLC program.

CO3: Analyze the need for automation, logical functions used in relays, types of programming languages, structure of the ladder program

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Textbook

1. Programmable Logic Controllers, Frank D Petruzella, McGraw Hill, 4th Edition, 2011.

Reference Books

1. Programmable Logic Controllers an Engineer's Guide, E A Parr, Newnes, 3rd Edition, 2013.

2. Introduction Programmable Logic Controllers, Gary Dunning, Cengage, 3rd Edition, 2006.

Web links and Video Lectures (e-Resources):

- https://www.tiga.us/blog/what-is-the-difference-between-plc-and-scada
- https://nptel.ac.in/courses/108105088
- https://nptel.ac.in/courses/108106022
-

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Take a MOOC's course on industrial automation.
- Write very basic ladder programs on https://app.plcsimulator.online/

27.09.2022

Semester-IV

MARITIME LAW (AEC)			
Course Code	**21MR483**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Understand admiralty law
- Learn about the history of admiralty law
- Understand Maritime Jurisdiction.
- Understand about ships as property
- Learn about maritime jurisdiction in India.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.

Module-1	
Admiralty Law: Nature of Admiralty Law,–Common law of sea – Sources of maritime law and admiralty law.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-2	
History of Admiralty Law: History of admiralty law in England, other parts of the world and in India – History of admiralty jurisdiction of High Courts of India, immunity of Government ships.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-3	
Admiralty and maritime jurisdiction: Enforcement of maritime claims by actions in rem and in personam – juridical personality of the ship, Extra territorial jurisdiction – Changing concept of maritime frontiers. International waters; International fisheries - Sea as a common heritage of mankind	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-4	
The ship as property: Ownership – registration – flag of convenience – ship construction rules – acquisition of ships – transfer of ships	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-5	
Maritime Jurisdiction in India: Jurisdiction in maritime ports; Access to maritime ports; Indian law – The maritime zones Act 1976; civil and criminal jurisdiction over ships; Ship owners liabilities for damage to ports – Limitation of ship owners liability.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning

Course outcome (Course Skill Set)

At the end of the course the student will be able:
CO1: To understand maritime law
CO2: To classify different types of jurisdiction
CO3: To demonstrate knowledge of the history of maritime law.
CO4: To identify the methods to apply maritime law in jurisdiction

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

3. First assignment at the end of 4th week of the semester
4. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Aleka Mandaraka – Sheppard – Modern Maritime Law (Second Edition)(2009)
2. D.C. Jackson, Enforcement of Maritime Claims, London: LLP (2005)
3. Southampton on Shipping Law, Informa (2008)
4. Halsbury's Laws of England, 4th Edn, London (1983)
5. Marsden, Collisions at Sea, London (1961)

Reference Books:

1. Chorly and Giles, Shipping Law, 6th Edn. London
2. Kochu Thommen, International Legislation on Shipping, U.N. New York

Web links and Video Lectures (e-Resources):

- https://en.wikipedia.org/wiki/Admiralty_law
- https://www.youtube.com/watch?v=0KDtbMhQfBI
- https://www.youtube.com/watch?v=Ont8bA-Yjk4
- https://lexforti.com/legal-news/maritime-laws-in-india/

27.09.2022

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case study on the Suez Canal crisis and its litigation.
- Presentation of key maritime legislations in India

MARINE ENGINEERING

Semester-V

THEORY OF MACHINES			
Course Code	**21MR51**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To understand the concept of machines, mechanisms and to analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms and governors
- To analyse the undesirable effects of imbalances resulting from prescribed motions in mechanism.
- To design and evaluate the performance of different cams and followers.
- To understand and appreciate the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions,

Velocity and Acceleration analysis of planar mechanisms Graphical method: Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis offour bar mechanism, slider crank mechanism using complex algebra method.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism, shaper mechanism.

Dynamic force analysis: D'Alembert's principle, analysis of four bar and slider crank mechanism, shaper mechanism.

Flywheel: Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing machine

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.

Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

Balancing of Rotating Masses: Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in the same plane and in different planes. Balancing of several rotating masses by balancing masses in the same plane and in different planes.

Balancing of Reciprocating Masses: Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces)

Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power.

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations- Equilibrium method, D'Alembert's principle, Determination of natural frequency of single degree freedom systems, Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement.

Forced vibrations: Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Critical speed.

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: To identify and enumerate different link based mechanisms with basic understanding of motion , Understand types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems (L1)

CO2: Understand the causes and effects of vibration in mechanical systems. (L2)

CO3: Develop schematic models for physical systems and formulate governing equations of motion and vibrations. (L3)

CO4: To analyse the mathematical models and to determine its response of real life engineering systems(L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Theory of Machines", Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd Ed-2009
3. "Theory of Machines", Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Ed 2006
4. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4thedition, 2003.
5. Mechanical Vibrations, V. P. Singh, Dhanpat Rai & Company, 3rdedition, 2006.

Additional References:

1. "Theory of Machines & Mechanisms", J.J. Uicker, , G.R. Pennock, J.E. Shigley, OXFORD 3rd Ed. 2009.
2. "Theory of Machines" Thomas Bevan, CBS Publication 1984.
3. "Design of Machinery" by Robert L. Norton, McGraw Hill, 2001.
4. Theory of Vibration with Applications, W. T. Thomson, M. D.Dahleh and C. Padmanabhan, Pearson Education Inc, 5thedition,2008.
5. Mechanical Vibrations: S. Graham Kelly, Schaum's outline Series,Tata McGraw Hill, Special Indian Edition, 2007

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112106270
https://onlinecourses.nptel.ac.in/noc20_me21/preview
https://nptel.ac.in/courses/112101096
https://nptel.ac.in/courses/112103111
https://nptel.ac.in/courses/112107212
https://nptel.ac.in/courses/112107087
http://edheads.org.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Mini Group Projects on working of Mechanisms
- Visit to the vibration laboratory and demonstrate the working of Governors, working of cams, balancing of rotating masses.
- Bring in everyday examples of simple machines and demonstrate how they work.

27.09.2022
Semester – V

MARINE IC ENGINES AND PROPULSION SYSTEM (IPCC)			
Course Code	**21MR52**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

- Theoretical and practical knowledge of the IC engine systems on ships.
- Understand the working of main engine components and their materials
- Explain the working and use of main engine systems.
- Explain the safe operating procedure of main engine
- Explain the working of propulsion systems.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

Principles of Internal Combustion Engines

Review of basic cycles :4-Stroke and 2-Stroke cycles

Deviation from Ideal Condition in actual engines, Timing Diagrams of 2- Stroke and 4-Stroke engines. Comparative study of slow speed, medium speed and high speed diesel engines – suitability and requirements for various purposes, Mean Piston speed, M.C.R. & C.S.R. ratings. Development of long-stroke Engines, multiplication of stroke-bore ratio

Measurement of engine speed, air flow, fuel consumption, Measurement of Brake Power and Indicated Power, indicator cards, Power Calculations, thermal efficiency, Performance curves, Heat Balance sheet and Multi cylinder Engines testing- Morse test. Makers Engine / Test bed Trials.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Components of Marine Main Engine

Cylinder head & its mountings -hydraulic exhaust valves, Liner and Jacket, piston & piston rings, piston rod , Cross head-guides, bearing, Connecting rod – crank pin bearings, main bearing, crank shaft, crankcase relief valves, thrust bearing, thrust block, Bed Plate, A-frame- Welded construction for Bed plates & frames, Tie rods, chocks- metallic, resin, foundation bolts, cylinder lubricators, drive gear, gear/chain, cam shaft, air cooler, turbocharger & system

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

27.09.2022

Main Engine Systems Main Lubricating system- Principles and lube oil properties, Cylinder lubricating system, L.O. treatments M/E Fuel oil system: Fuel and types: F.O. properties and requirements, F.O. treatments , F.O transfer system, fuel injection system - Jerk and Common rail systems, V.I.T &Electronic injection system. M/E cooling system: piston, cylinder head, liner cooling. M/E Air starting system, Main sea water system, Scavenge air system- Uniflow, loop, cross loop and reverse loop, Turbocharging system, injector cooling system, camshaft lube oil system.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE-4	**8 HOURS**
Safe Operation of Main engine & modern practices Control air system, control air dryer, manoeuvring system, reversing systems, starting of main engine, governor, over speed trip, starting air interlocks.Vibrations & its types, dampers & detuners. Main engine alignment, crankshaft deflection, piston & piston ring calibration, shaft generator, main engine safety and alarm system (low lube oil cut-out etc.), mist detector Emission control: NOx and SOx control systems, Camless engine, Dual fuel engine	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE 5	**8 HOURS**
Propulsion Systems Direct Propulsion System: Shafting, Thrust block, intermediate shaft & bearings, coupling bolts, muff coupling, propeller shaft, stern tube-water cooled & oil cooled, stern tube bearings, stern tube lube oil system, aft & forward seal details, propellers-keyed & keyless propellers, fixed pitch ,controlled pitch propeller, pilgrim nut, aft liner. A-bracket on passenger vessel Electrical propulsion, jet propulsion, propeller cavitation	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.No.	Experiments
1	Determination of calorific value of solid/liquid/ gaseous fuels
2	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
3	Valve Timing diagram of 4 stroke engine and port timing diagram of 2 stroke engine

27.09.2022

4-9	Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for a. Four stroke Diesel Engine b. Four stroke Petrol Engine c. Multi Cylinder Diesel/Petrol Engine, (Morse test) d. Two stroke Petrol Engine e. Variable Compression Ratio I.C. Engine.
10	Measurements of Exhaust Emissions of Petrol/diesel engine.
11	Exercises to reading and drawing of indicator diagram using planimeter and calculation of indicated power
12	Demonstration of pθ , pV plots using Computerized IC engine test rig
13	Demonstration: Sketch the layout of the fuel line/ cooling water line/ lube oil line

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: List basic cycles, Main engine parts, systems associated with Main engine and propulsion systems. (L1)

CO2:Explain timing diagrams, working of main engine components, fuel and Lube oil systems, control systems and propulsion systems (L2)

CO3: Select types of engines, components, piston rings and types of propulsion based on usage (L3)

CO4: Evaluate the performance of I C engines , components, systems and manoeuvring propulsion systems(L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

27.09.2022

Suggested Learning Resources:

Books:

1. Wood yard, Goug, "Pounder's Marine Diesel Engines''. 811, Edition, Butter Worth Heinemann Publishing, London, 2001.

2. S H Henshall, "Medium and High Speed Diesel Engines for Marine Use", 11, Edition, Institute of Marine Engineers, Mumbai, 1996.

3. Ganeshan. V, "Internal Combustion Engines, Tata McGraw Hill, 4th Edition, 2012.

Additional References:

1. D K Sanyal, "Principle & Practice of Marine Diesel Engines", 2nd Edition, Bhandarkar Publication, Mumbai, 1998.

2.Denis Griffiths ,Marine Low Speed Diesel Engines,Witherby,Revised edition 2020,ISBN-10 : 1856098796

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/103/112103262/
- http://vlabs.iitkgp.ernet.in/rtvlas/
- https://www.wartsila.com/encyclopedia/term/internal-combustion-engine

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Conduct interactive sessions on drawing of ship Indicator diagrams.
- Conduct Case studies on fires due to failure of I C engine systems.
- Group discussions on SOLAS Regulations Chapter II-4.
- Visit a ship in-campus to see the model of the Main engine and study the Main engine system.
- Design a prototype of an exhaust gas scrubber system.
- Review the papers on the latest advancements in Marine engine design.
- To observe the overhaul of the main engine piston in a ship-in campus.

27.09.2022

Semester-V

MECHANICS OF MATERIALS			
Course Code	**21MR53**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2-2-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To know the different types of stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.
- To know behaviour& properties of engineering materials.
- To understand the stresses developed in bars, compound bars, beams, shafts, and cylinders.
- To analyze the concepts of calculation of shear force and bending moment for beams with different load conditions and supports.
- To explore the concepts of Buckling of columns.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1	**8 HOURS**

Stresses and Strains: Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2	**8 HOURS**

Analysis of Stress and Strain: Introduction to three-dimensional state of stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear stress, Mohr circle for plane stress conditions.

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3	**8 HOURS**

Shear Force and Bending Moment: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads, uniformly distributed constant / varying loads. **Concept of shear center.**

Stress in Beams: Bending and shear stress distribution in rectangular, I and T section beams.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4	**8 HOURS**

Deflection of Beams: Relationship between moment, slope and deflection, Moment area method, Macaulay's method. Problems to calculate slope and deflection for determinant beams, Beams of uniform strength, Leaf springs.

Torsion: Circular solid and hollow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, strength of welded joints, torsion effect on welded joints

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Thick & Thin Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations.

Columns: Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, Secant formula for columns.

Introduction to Strain Energy: Strain energy due to axial, shear, bending, torsion and impact load. Castigliano's theorem I and II and their applications

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Understand the concept of stress and strain in structural problems (L2)

CO2: Apply the concept of different elastic functions, stress and strain to solve structural problems (L3)

CO3: Analyse the influence of various geometric and loading parameters in axial, bending, shear and torsion (L4)

CL4: Analyse concept of solid mechanics in designing structural members. (L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Mechanics of Materials, J M Gere, B J Goodno, Cengage Eighth edition 2013
2. Fundamentals of Strength of Materials, P N Chandramouli PHI Learning Pvt. Ltd 2013
3. Strength of Materials, R K Rajput S. Chand and Company Pvt. Ltd 2014
4. Strength of Materials, R. Subramanian Oxford 2005

Additional References:

1. Strength of Materials, S. S. Ratan Tata McGraw Hill 2nd Edition, 2008
2. Mechanics of materials and Strength of Materials, S C Pilli and N Balasubramanya Cengage 2019
3. Mechanics of Materials, Ferdinand Beer, Russell Johston, John Dewolf, David Mazurek, McGraw Hill Education (India) Pvt. Ltd Latest edition
4. Mechanics of Materials, R C Hibbeler, Pearson Latest edition

Web links and Video Lectures (e-Resources):

https://www.digimat.in/nptel/courses/video/112107147/L02.html
https://www.cpp.edu/meonline/strength-of-materials.shtml
https://nptel.ac.in/courses/105105108
https://www.springer.com/journal/11223

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Use of Simulation Softwares to model and analyse beams, columns, cylinders etc.

27.09.2022

Semester - V

SHIP STRUCTURE AND CONSTRUCTION			
Course Code	**21MR54**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Conceptual understanding of ship terms, section and materials use.
- Understanding of bottom and side framing and for-end and after- end arrangements
- Basic knowledge of shells and decks.
- Understanding of load line and tonnage
- Understanding of Ship Types and miscellaneous ship out fittings

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

SHIPS' TERMS, STRESSES AND MATERIALS USE

Ships Terms: General Classification of Ships.Various terms used in ship Construction with reference to Ship's parameter e.g. L.B.P., LOA, Moulded Depth, Moulded draught, and other similar terms.

Stresses in ship's structure: Bending, Shear, Hogging, Sagging, Racking, Pounding, Painting, etc., and Strength members to counteract the same.

Sections and materials use: Type of section like Angles, Bulb Plates, Flanged beams used in ship construction. Basic types of welding. Testing of welds.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

FRAMING AND SHIPS' END ARRANGEMENTS

Bottom & Side Framing : Double bottoms, Water tight floors, Solid and bracket floors, Longitudinal framing keels, side framing like Tankside brackets, Beam Knee, Web frame, etc,

Fore-End Arrangements: Stem construction, arrangements to resist panting, panting stringers, Forepeak — Collision bulkheads, Bulbous bows. Anchor and cable arrangements.

After-End-Arrangements: Types of Sterns, Stem frame and rudder. Types of rudder. Supporting of rudder, Shaft tunnel, Tunnel bearings.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

SHELL, DECKS, BULKHEAD & DEEP TANKS

Shell & Decks: Plating systems for shells, Deck plating & Deck girders, discontinuities like hatches and other openings, supporting & closing arrangements, mid-ship Section of ships.

Bulkheads & Deep Tanks: Watertight bulkheads, Arrangements of plating and stiffeners. Watertight sliding doors, Water tight openings through bulkheads for electric cables pipes and shafting. Deep tank for oil fuel or oil cargo corrugated bulkheads.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

LOADLINE AND SHIPYARD PRACTICE

Plimsol / Load line Mark, Tonnage regulations .Definition of freeboard and various assigning conditions, calculation as per latest convention. Shipyard Practice: Layout of a Shipyard, fabrication of assembly, subassembly and units in construction. Role of Surveyors in construction of Ship; Keel laying, Launching, Sea trial. Use of computers in ship design with cost implication.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE 5 **8 HOURS**

SHIP TYPES AND MISCELLANEOUS OUTFITS

Construction details of Tankers, bulk carriers, container ships, car carriers, LNG, LPG and chemical carriers, Lash ships; Passenger ships, Dredger, Tugs, and offshore platforms. Ship insulation, corrosion control and antifouling system, surface preparation and painting.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Locate and define frames, bulkheads, loadline, deep tanks, anti-fouling systems.(L1)

CO2: Classify and compare fore and aft end arrangements, plating systems, ship yard layouts, ship types wrt construction and materials (L2)

CO3: Explain stresses in ships: explain rudder construction, watertight bulkheads, watertight doors, sea trails, surface preparation of hulls (L2)

CO4: Apply the principles of Materials science and hydrostatics to study effects of stress on ship structures, fore and aft ends, midship sections , calculation of freeboard, offshore platforms(L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

.**Continuous Internal Evaluation:**

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

27.09.2022

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books:

1. Russell, P.A. and Stokoe, E.A.,Reeds Vol 5: Ship Construction for Marine Engineers,Bloomsbury USA,2021, ISBN: ,9781472980687

2. Eyres, D.J.,Ship Construction,Elsevier Science,2006,ISBN: 9780080468235

Additional References:

1. Munro-Smith, R.,Merchant Ship Types,Institute of Marine Engineers,1975,ISBN:9780900976261

2. Pursey, H.J.,Merchant Ship Construction,State Mutual Book Periodical Service Limited,1987,ISBN: 9780785560548

Web links and Video Lectures (e-Resources):

1: https://nptel.ac.in/courses/114105004

2: https://nptel.ac.in/courses/114105031

3: https://www.digimat.in/nptel/courses/video/114105004/L15.html

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Construction of ship model and report
- Ship and port visit and prepare a report on the constructional features
- Report and presentation on shipyards in India.
- Case study on the Sagarmala project in India.

27.09.2022

Semester-V

DESIGN LABORATORY			
Course Code	**21MRL55**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2*-0	SEE Marks	50
Credits	01	Exam Hours	03

**** Additional one hour may be considered for instructions if required.***

Course objectives:

The students will be able

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses and influence of gyroscopic couple.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.
- To visualize different mechanisms and cam motions

Sl.NO	Experiments
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor.
5	Determination of Pressure distribution in Journal bearing
6	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
7	Determination of stresses in Curved beam using strain gauge.
8	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc
9	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending).
10	Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression,
	Demonstration Experiments (For CIE)
11	**Demonstration and study of operation of different Mechanisms and their Inversions:** Slider crank chain, Double slider crank chain and its inversions, Quick return motion mechanisms- Peaucellier's mechanism. Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, Ackerman steering gear mechanism.
12	
13	Demonstration and Study of different types of cams, types of followers and typical follower motions. Obtain cam profile for any two types of follower motions and types of follower

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.

CO2: Carry out balancing of rotating masses and gyroscope phenomenon and analyse the governor characteristics.

CO3: Determine stresses in disk, beams and plates using photo elastic bench and determination of Pressure distribution in Journal bearing

CO4: Realize different mechanisms and cam motions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE). In total the student has to secure 40% of total marks of CIE+SEE.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Rattan S.S , Theory of Machines, Tata McGraw-Hill Publishing Company, 2014
2. M. M. Frotch, Experimental Stress analysis, McGraw-Hill

27.09.2022

Semester-V

INTRODUCTION TO AI AND ML (AEC)			
Course Code	**21MR581**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

Understands the basics of AI, history of AI and its foundations, basic principles of AI for problem solving

Explore the basics of Machine Learning & Machine Learning process, understanding data

Understand the Working of Artificial Neural Networks

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it

Module-1	
Introduction: What is AI, The foundation of Artificial Intelligence, The history of Artificial Intelligence, Intelligent Agents Textbook 1: Chapter: 1 and 2	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-2	
Problem solving by searching: Problem solving agents, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions Textbook 1: Chapter: 3	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-3	
Introduction to machine learning: Need for Machine Learning, Machine Learning Explained, and Machine Learning in relation to other fields, Types of Machine Learning. Challenges of Machine Learning, Machine Learning process, Machine Learning applications. **Understanding Data**: What is data, types of data, Big data analytics and types of analytics Textbook 2: Chapter: 1 and 2.1 to 2.5	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-4	
Understanding Data: Bivariate and Multivariate data, Multivariate statistics , Essential mathematics for Multivariate data, Overview hypothesis **Basics of Learning Theory**: Introduction concept learning. Textbook 2: Chapter: 2.6 to 2.10, 3.1 to 3.4, 4.1 to 4.3	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-5
Artificial Neural Network: Introduction, Biological neurons, Artificial neurons, Perceptron and learning theory, types of Artificial neural Network

Textbook 2: Chapter: 10

Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Understands the basics of AI, ML and ANN (L2)

CO2: Describe applications of AI, ML and ANN (L2)

CO3: Illustrate the simple learning algorithms to predict the outputs.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Textbooks

1. Stuart Russel, Peter Norvig: “Artificial Intelligence A Modern Approach”, 3rd Edition, Pearson Education, 2015.
2. S. Sridhar, M Vijayalakshmi “Machine Learning”. Oxford ,2021

Reference Books:

1. Elaine Rich, Kevin Knight: “Artificial Intelligence”, 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709
2. Nils J. Nilsson: “Principles of Artificial Intelligence”, Elsevier, 1980, ISBN: 978-3-540-11340-9.

Web links and Video Lectures (e-Resources):

1. http://stpk.cs.rtu.lv/sites/all/files/stpk/materiali/MI/Artificial%20Intelligence%20A%20Modern%20Approach.pdf.
2. http://www.getfreeebooks.com/16-sites-with-free-artificial-intelligence-ebooks/https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_overview.htm
3. Problem solving agent:https://www.youtube.com/watch?v=KTPmo-KsOis.
3. https://www.youtube.com/watch?v=X_Qt0U66aH0&list=PLwdnzlV3ogoXaceHrrFVZCJKbm_laSHcH
4. https://www.javatpoint.com/history-of-artificial-intelligence
5. https://www.tutorialandexample.com/problem-solving-in-artificial-intelligence
6. https://techvidvan.com/tutorials/ai-heuristic-search/
7. https://www.analyticsvidhya.com/machine-learning/
8. https://www.hackerearth.com/practice/machine-learning/machine-learning-algorithms/mldecision-tree/tutorial/
9. https://www.javatpoint.com/unsupervised-artificial-neural-networks

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Real world problem solving: Demonstration of projects related to AI and ML.

27.09.2022

Semester-V

SENSORS & ACTUATORS (AEC)			
Course Code	**21MR582**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- To provide the fundamental knowledge about sensors and measurement system.
- To impart the knowledge of static and dynamic characteristics of instruments and understand the factors in selection of instruments for measurement.
- To discuss the principle, design and working of transducers for the measurement of physical time varying quantities.
- To Understand the working of various actuators suitable in industrial process control systems

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it

Module-1

Sensors and measurement system: Sensors and transducers, Classifications of transducers-primary & secondary, active & passive, analog and digital transducers. Smart sensors.

Measurement: Definition, significance of measurement, instruments and measurement systems. Mechanical, electrical and electronic instruments.

Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-2

Static and Dynamic Characteristics: Static calibration and error calibration curve, accuracy andprecision, indications of precision, static error, scale range and scale span, factors influencing the choice of transducers/instruments.

Dynamic response – Dynamic characteristics, natural frequency and Damping ratio.

Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-3

Measurement of Temperature: RTD, Thermistor, Thermocouple, Thermopile, AD590.

Measurement of Displacement: Introduction, Principles of Transduction, Variable resistance devices, variable Inductance Transducer, Variable Capacitance Transducer

Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-4

Measurement of Strain: Introduction, Types of Strain Gauges, Theory of operation of resistance straingauges, Applications.

Measurement of Force & Torque: Introduction, Force measuring sensor –Load cells, Hydraulic load cell,

electronic weighing system**.** Torque measurement	
Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Module-5

Actuators and process control system: Introduction. Block diagram and description of process control system with an example, Actuators, Control elements.

Electrical actuating systems: Solid-state switches, Solenoids

Pneumatic Actuators, Hydraulic Actuators

Teaching-Learning Process	Chalk and board, Active Learning, Demonstration

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Understand the fundamental concepts of sensors and actuator system.(L2)

CO2: Describe the principle and working of different types of sensors and actuators used in industrial application.(L2)

CO3: Illustrate the applications of different transducers for temperature, displacement, level, strain, force and torque measurements

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Textbook

1. Electrical and Electronic Measurements and Instrumentation, A K Sawhney, 17th Edition, (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.

2. Instrumentation: Devices and Systems, C S Rangan, G R Sarma, V S V Mani, 2nd Edition (32 Reprint), McGraw Hill Education (India), 2014.

3. Process Control Instrumentation Technology by C D Johnson, 7th Edition, Pearson Education Private Limited, New Delhi 2002.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_ee32/preview
- https://archive.nptel.ac.in/courses/108/108/108108147/
- https://www.youtube.com/watch?v=HMNYf1QQ83U

27.09.2022

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- A small project to use sensors to study home activities.
- Design Smart Digital SchoolBell with Timetable Display.
- Design contactless water level controller.

27.09.2022

Semester-V

SEAMANSHIP AND NAVIGATION (AEC)			
Course Code	**21MR583**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Understand the basics of navigation.
- Understand the basics of meteorology for navigators.
- Understand the basics of communication devices on ship.
- Understand the basics of ropework and mooring.
- Understand the basics of watchkeeping on the bridge.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it

Module-1	
Introduction to Navigation: History of navigation, Types of navigation, Navigational aids, Voyage planning	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-2	
Introduction to Meteorology: meteorological terms, Weather scales and beaufort scale, Interpretation of a synoptic weather chart, Ice navigation, types of clouds.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-3	
Communication on ships: Communication devices on ship, GMDSS, EPIRB, SART, International signal of flags, Phonetic alphabets,	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-4	
Mooring and ropework: Type of ropes, Lay of ropes, Synthetic fiber ropes, Handling of ropes, mooring of ships,Types knots and hitches.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning
Module-5	
Watchkeeping for navigators: Duties of officers on bridge OOW, integrated bridge and its function, duties of a lookout , calling the master, helm orders, publications on bridge, anchoring and rigging of the pilot ladder	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning

27.09.2022

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: To define types of navigation, meteorology, phonetic alphabets, mooring, watchkeeping.(L1)

CO2: To classify navigation, types of mooring ropes, HLM orders, waves.(L2)

CO3: To explain voyage planning, weather charts, handling of ropes, anchoring.(L2)

CO4: To apply rules of seamanship during navigation, voyage planning, tying of knots, dropping of an anchor(L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. D.J. House,Seamanship Techniques: Shipboard and Marine Operations,Routledge; 4th edition,ISBN-10 : 0415810051
2. G. L Danton,The theory and practice of seamanship,Routledge; 1st edition,ISBN-10 : 0415153727

Reference Books:

1. Angus Ferguson,Seamanship Notes,Seamanship International Ltd,ISBN-10 : 0953437965

Web links and Video Lectures (e-Resources):

- https://www.seamanshiptutor.com/?page_id=22
- https://www.navyresources.net/navyresources/navigation-seamanship
- https://www.youtube.com/watch?v=uKPstEBcmeI
- https://www.youtube.com/watch?v=g3V9nN59DLY
-

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Field tour on cloud identification.
- Practical session on knots.
- Practical session on identification of stars.

MARINE ENGINEERING

Semester-VI

SHIP OPERATIONS AND MANAGEMENT			
Course Code	**21MR61**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To understand the concepts of Ship operations.
- To understand the concepts of Freight Rates, voyage planning, marine Insurance
- To understand the organizational structure of a shipping company.
- To get familiarized with various chartering methods, Bill of Lading and different paper works on board a merchant vessel

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1	**8 HOURS**
Introduction to Ship Management: Modern shipping practice. Marine vehicles and cargo, care of cargo against damage. Cargoes, stowage of cargo and cargo information. Stowage factor. Care and securing of cargo Damage of cargo Development in shipping and cargo handling. Multimodal transportation, Liner and tramp shipping services. Shipping companies- Owned and ship management company, organization structure.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2	**8 HOURS**
Agents and Agencies: Ports and other intermediaries – Stevedores, Agent and Agency. Port clearance, Custom clearance – Ship documents for inward and outward clearance and procedure. Import and export procedure and documents for import and export. Procedure to convert foreign going vessels into coastal vessels and vice versa.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3	**8 HOURS**
Marine Insurance: Risk and risk control. Classification of insurance business. Principles of insurance and Types. Important clauses of Hull, cargo and freight insurance and their importance. General average, Characteristics of General Average Particular average P&I clubs, Underwriting claims. Insurance companies in India. Reinsurance	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations

	3. Chalk and Talk.

MODULE-4	**8 HOURS**
Chartering: Terms used in commercial shipping- Bill of lading and types. Clauses in Bill of lading. Issues with Bill of lading. Seaway bill Freight and type of freight, Lein, Chartering of vessel and types of charter. In Charter, Out charter. Charter terminology – types of days in a Charter party. Charter party clauses. Fixation of vessel Voyage estimate	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5	**8 HOURS**
Maritime Law: International laws of the sea. Limitation of shipowners liability. Carriage of Goods by Sea Act 1971. York – Antwerp rules Maritime safety and security – Employment of seafarers, ILO, MLC convention Maritime Business contracts. Maritime disputes and settlements, Arbitration .Maritime Jurisdictions (Admiralty courts) and Judicial process in India.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Describe the agents and agencies, conference systems, marine insurance, shipping act, shipping companies, Marine law (L1)

CO2: Classify marine vehicles, charter parties, types of marine insurance, ships papers, types of shipping companies, marine disputes. (L2)

CO3: Explain cargo handling, freight rates, P and I clubs, port procedures, manning of ships, marine arbitration (L2)

CO4: Illustrate - damage to cargo, rate fixation,loss adjusting principles, duties during emergencies, voyage planning, admiralty law.(L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Edward F. Stevens & C.S.J. Butterfield ,Shipping Practice, 11th Edition, 1981,ISBN:9788175980105'
2. John. W. Dicke. 2014,Reeds 21st Century Ship Management. Bloomsbury Publishing, U.K.

Reference Books:

1. John. W. Dicke. 2014,Reeds 21st Century Ship Management. Bloomsbury Publishing, U.K.
2. ICS .2011/12, Ship Operations and Management. London, UK.
3. Luny.H.V., Lai K.-H., Cheng T.C.E. Cheng. 2010, Shipping And Logistics Management." Springer, U.K.
4. Proshanto K.Mukherjee,Mark Brownrigg (2013), Farthing On International Shipping.4th Edition, Springer.

Web links and Video Lectures (e-Resources):

- www.consulting.xerox.com/case-studies/...shipping-co/enus.html (International Shipping Company Case Study)
- www.sugarcrm.com/industry/shipping-and-transport/case-study(CRM Shipping and Transport Case Studies) http://businesscasestudies.co.uk(Shipping Sector-Case Studies)
- www.tcs.com › Home › Resources › Case Studies(TCS Resources: Case Study Leading Indian Shipping)
- http://www.sbaglobal.com(SBA Global Logistics Services-Case Studies)
- www.ellenmacarthurfoundation.org/case_studies/maersk(Maersk Line-Case Studies)
- http://www.imo.org/en/KnowledgeCentre/Pages/Default.aspx(Maritime Knowledge Centre-International Maritime University)

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case studies on ship chartering.
- Mock company meeting
- Case studies on arbitration

27.09.2022

Semester -VI

MARINE THERMAL ENGINEERING (IPCC)			
Course Code	**21MR62**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

- To understand the fundamentals of heat transfer
- To study the steady and transient heat conduction
- To understand the mechanism of free and forced convection
- To understand radiation heat transfer mechanism and performance parameters of heat exchangers.
- To analyse refrigeration and air conditioning systems

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

Introductory Concepts and definition:*Review of basics of Modes of Heat Transfer*

Conduction-Basic Equations: General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds.Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation

Extended surfaces: Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient.

Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder and flow inside the duct.

Free or Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Radiation Heat transfer: (Review of basic laws of thermal radiation) Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces

Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers, Compact heat exchangers.

27.09.2022

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 **8 HOURS**

Refrigeration: Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, reversed Carnot cycle, vapour absorption refrigeration system and Air refrigeration system. Use of refrigeration tables and p-h chart- numericals. Typical marine refrigerating plants with multiple compression and evaporator system

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-5 **8 HOURS**

Psychrometrics: Atmospheric air and Psychrometric properties: DBT, WBT, DPT, partial pressure, specific and relative humidity and relation between the enthalpy and adiabatic saturation temperatures, psychrometric charts. Analysis of various processes: Heating, cooling, dehumidifying and humidifying. Adiabatic mixing of streams of moist air. - numericals

Marine air conditioning-Air circulation system, container cooling system, air cooler fans, air conditioning system in cargo ship.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in free Convection
5	Determination of Heat Transfer Coefficient in a Forced Convention
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
8	Experiment on Transient Conduction Heat Transfer.
9	Using one dimensional transient conduction, experimentally demonstrate estimation of thermal conductivity and thermal diffusivity
10	Performance test on Vapour compression refrigeration -test rig.
11	Performance test on Air conditioning-test rig.
12	Experiments on Boiling of Liquid and Condensation of Vapour (Demonstration)

13	Use of CFD for demonstrating heat transfer mechanism considering practical applications

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Explain the basic modes of heat transfer

CO2: Apply the laws of heat transfer for engineering problems

CO3: Solve thermal problems using correlations and charts/tables

CO4: Analyze various thermal systems by applying fundamental laws

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of

all questions should not be more than the 20 marks.

- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Heat & Mass transfer, Tirumaleshwar, Pearson education 2006
2. Heat transfer, a practical approach, Yunus A. Cengel , Tata Mc Graw Hill Fifth edition
3. Heat transfer-A basic approach, N. Ozisik, Tata McGraw Hill 2002
4. Fundamentals of Heat and Mass Transfer Incropera, F. P. and DeWitt, D. P, John Wiley and, Sons, New York 5th Edition 2006
5. Basic and Applied Thermodynamics, P K Nag, 2nd Ed., Tata McGraw Hill Publications, 2017.

Web links and Video Lectures (e-Resources):

- Heat Transfer, IIT Guwahati, Dr. Anil Verma, https://nptel.ac.in/courses/103103032
- Heat and Mass Transfer, IISc Bangalore, Prof. Pradip Dutta, https://nptel.ac.in/courses/112108149

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to thermal power plant and make a report
- Make presentations on latest research work in the field of heat transfer
- Visit to refrigerator/ air conditioner manufacturing/service units and make report
- Visit to ports and make a study report on thermal systems used on board ships

27.09.2022

Semester-VI

NAVALARCHITECTURE			
Course Code	**21MR63**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- An ability to apply knowledge of mathematics, science, and engineering within naval architecture and marine engineering;
- To understand Basic hydrostatics, Geometry of ship;
- Calculations of ship forms and various coefficients: Calculating the area of wetted surface, volume etc.
- An understanding of the various types of Propellers and Rudders;
- An understanding of and experience in marine system conceptual and preliminary design using industrial capability.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Geometry of Ship, Hydrostatic Calculations

Ships lines, Displacement Calculation, pressure exerted by a liquid, load on immersed plane ,centre of pressure, load diagram shearing force on bulkhead stiffener, Simpson's first rule, application to volumes, use of intermediate ordinates application to first and second moments of area. Familiarisation with hydrostatic curves of the ship, problems.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

T.P.C, Coefficient of forms, Centre of Gravity

T.P.C, Coefficient of forms: Concept of DWT, GT and NT, Tonnes per Cm. Immersion, Coefficient of forms, wetted surface area, Similar figures, shearing force and bending moment

Centre of gravity: Effect of addition and removal of masses, Effect of movement of mass, Effect of suspended mass calculations.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Stability of ships

Statical stability at small angles of heel. Calculation on BM, metacentric diagram inclining experiment, free surface effect, stability at large angle of heel, stability of wall sided vessel. Problems.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

Trim, Resistance

Trim: Change in draughts due to added masses, change in mean draught and end draught due to density, change in mean draught and end draught due to bilging MCTI, change of L.C.B. with change of trim, Change of trim due to adding or deducting weights, change in draft & trim because Of' filling/flooding several tanks with different densities, Change in draft due to change in density. Problems.

Resistance: Frictional, residuary and total resistance, Admiralty coefficient, fuel co-efficient and consumption, problems.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Propeller and Rudder Theory

Propeller: Geometry of screw propeller, types of propeller, Blade element theory Apparent and real slip, wake, thrust, relation between powers, built and solid propellers, measurement of pitch, cavitation.

Rudder: Force on rudder, types of rudders, model experiments and turning trails, torque on stock, angle of heel due to force on rudder, angle of heel when turning, problems.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Define and explain various terms related to geometry of ship, hydrostatics, and stability of ship, propellers and rudders.(L2)

CO2: Apply the principle of hydrostatics, numerical integration (simpson's rule), forces on rudder and various conditions of stability of ships.(L3)

CO3: Analyse the stability of ships using the principle of hydrostatics.(L4)

CO4: Examine the conditions for stability of ships in real world scenarios.(L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Munro-Smith, R.. Ships and Naval Architecture. United Kingdom, Witherby, 2020.
2. Stokoe, E A, and Pemberton, Richard. Reeds Vol 4: Naval Architecture for Marine Engineers. United Kingdom, Bloomsbury Publishing, 2018.

Reference Books:

1. K. J. Rawson and E. C. Tupper, "Basic ship theory" (vol II), 5TH edition, Butterheinmann London 2001
2. E A Stokoe , "Naval Architecture for Marine Engineers" vol 4, reeds publications, 2000
3. G.N. Hatdh, "creative naval architecture", 1st Edition, Thomas reed publications, London 1971

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/114105003
- https://www.courses.com/indian-institute-of-technology-kharagpur
- https://www.courses.com/indian-institute-of-technology-kharagpur
- https://www.courses.com/indian-institute-of-technology-kharagpur
- https://www.courses.com/indian-institute-of-technology-kharagpur

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Study the basics of one design software for naval architecture.
- Design an experiment to find out TPC.
- Study the design changes that have happened because of SOLAS on merchant vessels.

27.09.2022

Semester- VI

CONTROL ENGINEERING AND MARINE AUTOMATION			
Course Code	**21MR641**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To understand the fundamental concepts of Control systems and mathematical modeling of the system.
- To analyze the basics of stability analysis of the system.
- To analyse system response using logarithmic plots and root locus.
- To understand the basics of automation
- To design hydraulic and pneumatic circuits for automation

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

INTRODUCTION TO CONTROL SYSTEMS AND MATHEMATICAL MODELS

Introduction: Control system, Basic structure of control system, open and closed loop control systems, concept of feedback, various terminologies used in control systems: Plant, Process, system, disturbances, controlled variable, manipulated variable, transfer function etc. Various classifications of control systems, Application areas with examples. Mathematical Models: Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems, Force Voltage and Force Current Analogy

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

STABILITY ANALYSIS

Basic concept of Proportional control, Integral control, derivative control, proportional plus derivation control, PID control. Stability Analysis: Types of input signals, First order and second order system response to step input, steady-state error, system types, System stability criteria, Routh criteria, Numerical Problems

Block diagram reduction technique, signal flow graph – Masons Gain formula

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3	**8 HOURS**
SYSTEM ANALYSIS USING LOGARITHMIC PLOTS AND ROOT LOCUS: Logarithmic Plots: Stability analysis using Bode diagrams, simplified Bode diagrams (Numerical Problems). Need of frequency response analysis, Sinusoidal response of linear system, methods used infrequency response, Frequency domain specifications. Root Locus: Terminologies – Poles, Loci, Complex roots etc. General rules for construction of Root Locus plots, analysis using root locus plot. (Numerical Problems)	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE-4	**8 HOURS**
INTRODUCTION TO AUTOMATION : Basic principles and strategies of automation, Overview of industrial control systems , Hardware components; sensors, actuators, Logic control systems Programmable Logic Controllers, Microcontrollers, Advantages & disadvantages of PLC, memory structure of PLC, ladder diagram examples, Industrial logic control systems logic diagramming, programmable controllers.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE-5	**8 HOURS**
HYDRAULICS AND PNEUMATICS: Design of Hydraulic drives, hydraulic Circuit design, Components of pneumatic systems, Compressors, Pneumatic valves, pneumatic drives, design of pneumatic circuits. Physical concepts of pneumatics and electricals. Electro-Pneumatic components operation and application interpretation of electric ladder diagram. PPI & PID – controllers Application of Controls on Ships: Fuel oil viscosity control,Jacket/piston cooling temperature control	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: To understand various types of control systems and automation (L2).

CO2: To describe mathematical models of control systems, stability analysis, basic principles of automation(L2)

CO3: Apply mathematical models for mechanical control systems,PID controls, logarithmic plots, hydraulic systems(L3)

CO4:Analyse control systems used in automation (L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration**

01 hours)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010
2. Nagrath, I.J, Gopal,Madan, "A Textbook of Control Systems Engineering"New Age International, 2008
3. Barapate, "Control System" Tech Max publications, Pune,2006
4. Nagoorkani A " Control System," RBA publications, Chennai, 2006

Reference Books:

1. Richard Dorf & Robert Bishop, "Modern control system", Pearson Education, New Jersey 2005.
2. Gopal M, "Digital Control and State variable Methods", Tata McGrawHill, New Delhi, 2003
3. B.S Manke, "Linear Control Systems," Hanna Publications, Delhi 2002
4. B.C Kuo, "Automatic control systems", Prentice Hall, New Delhi, 2002.

Web links and Video Lectures (e-Resources):

- https://electrotechnical-officer.com/all-about-control-panels-control-system-on-ship/
- https://www.youtube.com/watch?v=4iNThvr8nvM
- https://www.youtube.com/watch?v=MCpKB5Gy7i8

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Write small PLC Programs on Industrial Automation.
- Develop a prototype of a robot arm using Arduino.
- Preparation of charts showing the examples of open loop and closed loop control system

27.09.2022

Semester-VI

MARINE ENVIRONMENTAL PROTECTION			
Course Code	**21MR642**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To give the students a knowledge of Understand how IMO works and its function in international shipping
- Understand the regulatory process and the statutory regulations.
- How the working of the regulatory process and the statutory regulations of the bunkering process.
- To make the student aware of working knowledge of BWT, MARPOL and STCW regulations.
- To gain an understanding of emission surveying and its regulations.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

MARINE ENVIRONMENT

Marine environmental awareness. Marine ecology, seas and coastal areas. Ship's discharges to the sea and their environmental impact.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

BUNKERING

Precautions during bunkering, loading discharging oil cargo, tank cleaning, pumping out bilges, and knowledge of construction and operation of oil pollution prevention equipment in Engine room, and on various types of ships.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

BALLAST WATER MANAGEMENT

MARPOL 73/78-All Annexes, equipment requirements and their documentation, including necessary Record Books. Ballast Water Management Convention 2004. Anti-Fouling Convention 2001. Oil Pollution Act 1990. Knowledge of Codes of Safety Working practices as published – Knowledge of type of information issued by D.G. Shipping with regard to safety at sea & safe working practices.

27.09.2022

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4	**8 HOURS**
ANNEX Responsibilities under the relevant requirements of the international Convention for the prevention of Pollution from Ships – Annex I, Annex II, Annex III, Annex IV, Annex V, Annex VI. DSEC-9 Ballast Water Management Convention 2004. Anti-Fouling Convention 2001. Oil Pollution Act 1990.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5	**8 HOURS**
EMISSIONS MEASURES Environmental impact of accidental and operational discharges. Emissions to air from ships. Other pollutants. Proactive measures to control pollution and maintain the environment. Emergency situations-action to be taken to protect and safeguard the environment.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Identify and define various types of convention, MARPOL Annexes ,ballast water management (L1)

CO2:Classify the marine environmental pollution & its impact (L2)

CO3: Explain the operation of pollution prevention equipments and MARPOL requirements & documentation (L2)

CO4: Identify the OPA 90 & antifouling convention and apply environmental impact of accidental & operational discharges scenarios. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Vikram Gokhale, N.Nanda,"Ship's Safety And Environmental Protection", N.G Series, 4th edition, 2011.
2. Nanda and Gokhale, "Basic Marine Engineering Knowledge" N.G Series, 4th edition, 2011
3. MARPOL Consolidated Edition 2011: Articles, Protocols, Annexes, Unified Interpretations of the International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the 1978 and 1997 Protocols. United Kingdom, IMO, 2011.

Reference Books:

1. SOLAS Consolidated Edition 2020, International Maritime Organization; 7th ed.,2020,ISBN-13 : 978-9280116908
2. MARPOL Consolidated Edition 2018 (Vol A & B), Bhandarkar Publications; 2016th edition, 2018,ASIN : B071DFXF3H

Web links and Video Lectures (e-Resources):

- https://www.imo.org/en/OurWork/Environment/Pages/Default.aspx
- https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/MEPC-default.aspx
- https://indiancoastguard.gov.in/content/246_3_MarineEnvironmentProtection.aspx

27.09.2022

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Write a report on the efforts in India for environmentally sustainable growth.
- Do a case study on ports and its effect on the coastal environment.
- Do a poster presentation on IMO's efforts on sustainability.

27.09.2022

Semester VI

MEMS AND MICROSYSTEM TECHNOLOGY			
Course Code	**21MR643**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To educate on the rudiments of Microfabrication techniques.
- To introduce various sensors and actuators.
- To introduce different materials used for MEMS.
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1	**8 HOURS**
Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Microfabrication - Silicon-based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.	
Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations.

Module-2	**8 HOURS**
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo-mechanics, Fracture Mechanics, and Thin Film Mechanics. Assembly and System Integration. Packaging- Multi-Chip Modules, Passivation, and Encapsulation.	
Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations.

Module-3	**8 HOURS**
Electrostatic sensors – Parallel plate capacitors -Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile, and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia, Acoustic, Tactile and Flow sensors.	

27.09.2022

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations.

Module-4	**8 HOURS**
Photolithography, Materials for Micromachining- Substrates, Additive Films, and Materials; Bulk Micromachining - Wet Etching, Dry Etching, Plasma Etching, Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas-Phase Etchants; Surface Micromachining- Fusion Bonding; High-Aspect-Ratio-Micromachining – LIGA, Laser Micromachining; Computer-Aided Design; Assembly and System Integration; Packaging - Multi-Chip Modules, Passivation, and Encapsulation	

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations.

Module-5	**8 HOURS**
POLYMER AND OPTICAL MEMS: Polymers in MEMS– Polyimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow, and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.	

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Explain MEMS Technology, micro-sensors, fabrication processes for producing micro-sensors

CO2: Understand the operation of micro devices, microsystems, and their applications.

CO3: Design the micro devices and microsystems using the MEMS fabrication process.

CO4: Apply Reliability and Failure Analysis Testing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Allen James J, Micro-Electromechanical System Design, First edition, Taylor and Francis, FL (USA), 2005.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cenage Learning.
3. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
4. Maluf Nadim and Williams Kirt, An Introduction to Microelectromechanical Systems Engineering, Second Edition, ARTECH House, MA (USA), 2004.
5. N. Maluf," An Introduction to Micro-electro Mechanical System Engineering," Artech. House
6. S. Senturia," Microsystem Design", Springer
7. Tai-Ran Hsu, MEMS, and Microsystems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, Wiley.

Web links and Video Lectures (e-Resources):

- https://engineeringproductdesign.com/mems-micro-electro-mechanical-system/
- http://www2.nkfust.edu.tw/~cjli/MEMS/Chapter_1.doc

• https://www.youtube.com/watch?v=j9y0gfN9WMg
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Students are segregated in groups of 5 members made to Prepare models of FCC structure of Silicon and Patterns to demonstrate the process of Photolithography. • Students are segregated in groups of 5 members made to Prepare models of Cantilever Beam to analyze the vibration control and Patterns to demonstrate the process of Etching. • Quiz

Semester-VI

INTRODUCTION TO SHIPS AND SHIPPING			
Course Code	**21MR651**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- The student will gain the knowledge of the basics of ships and their construction.
- The student will gain a knowledge of the fundamentals of engine room machinery.
- The student will gain a knowledge of navigation and survival at sea.
- The student will gain a knowledge of the rules and organisations that govern shipping.
- The student will gain a knowledge of the basics of the business of shipping.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Ships: Brief history of ships, Types of ships, Merchant vessels, Types of cargo carried by the ships, sections and parts of a ship, Longitudinal view of a general cargo ship, Mid ship section of some ships, Ranks and job descriptions of ship's crew.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Engine room machinery: Lay out of the engine room, Types of machinery in the engine room, Main propulsion machinery- main engine and its parts, auxiliary machinery - Brief introduction to Auxiliary engine, pumps, MARPOL equipment, heat exchangers, boilers and cargo handling equipment.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

27.09.2022

Navigation and seamanship: Introduction to Navigation, types of navigation, Bridge and its equipment, LSA and FFA equipment, Life Boats and Life Rafts - items on a lifeboat and life raft and its uses, types, survival in a lifeboat.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

IMO and shipping: Organisations associated with shipping, IMO and DG shipping, IMO conventions, MARPOL, STCW, SOLAS,ILO,ISPS

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Business of shipping and port operations: Geography of sea trade, imports and exports using ships, volume of scale, ports in India and major ports around the world, cargo operations in ports, cargo equipment in ports for various cargo ownership and management companies, containerisation, chartering, shipping documents.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Identify and define various types Tankers,special duty vessels and its operations (L1)

CO2:Classify the tankers and special duty vessels (L2)

CO3: Explain cargo operations and regulations for safety for all types of tankers and Special duty vessels (L2)

CO4: Identify ship layouts, vessel types; requirements of competence and apply principles of seamanship to specific emergency scenarios. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. J. K. Dhar, Basic Marine Engineering, 11th Edition,2019,G-Maritime Publications , ISBN:GMPISBN01.
2. David House, Seamanship Techniques: Shipboard and Marine Operations ,5th Edition ,2018, Routledge ,ISBN-13 978-1138676114.
3. John W Dickie,Reeds 21st Century Ship Management,London ; New York : Adlard Coles Nautical,ISBN:9781472900685, 2014

Reference Books:

1. SOLAS Consolidated Edition 2020, International Maritime Organization; 7th ed.,2020,ISBN-13 : 978-9280116908
2. MARPOL Consolidated Edition 2018 (Vol A & B), Bhandarkar Publications; 2016th edition, 2018,ASIN : B071DFXF3H

Web links and Video Lectures (e-Resources):

- https://www.imo.org/en/KnowledgeCentre/ConferencesMeetings/Pages/SOLAS.aspx
- https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx
- https://www.youtube.com/watch?v=Q7Espb0afMw
- https://www.dieselduck.info/index.html
- https://www.youtube.com/channel/UClH53bXYykb-erNZ_kVBtOQ

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case study on SOLAS and MARPOL
- Ship models to be made in groups to study various ship structures
- Presentations on various shipping accidents and their case studies.

27.09.2022

Semester-VI

SUPPLY CHAIN MANAGEMENT & INTRODUCTION TO SAP			
Course Code	**21MR652**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 hours

Course objectives:

- To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
- To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.
- To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.
- To understand the usage of SAP material management system

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different type of teaching methods to develop the outcomes through Power-Point Presentation and Video demonstration or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Discuss the case studies and how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information.

MODULE-1	**8 HOURS**
Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures. **Strategic Sourcing Outsourcing** – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

MODULE-2	**8 HOURS**
Warehouse Management Stores management-stores systems and procedures-incoming materials control storesaccounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement. **Supply Chain Network Distribution Network Design** – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

MODULE-3	**8 HOURS**
Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design, decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.	

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

MODULE-4 **8 HOURS**

Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain- E-Business in supply chain.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

MODULE-4 **8 HOURS**

Introduction to SAP, SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Understand the framework and scope of supply chain management, basics of SAP, impact of IT on Supply chain.

CO2: Understand how to manage a competitive supply chain using strategies, models, techniques and information technology.

CO3: Apply planning for demand, inventory and supply

CO4: Optimize supply chain network.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

27.09.2022

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

3. The question paper will have ten questions. Each question is set for 20 marks.
4. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Janat Shah, Supply Chain Management– Text and Cases, Pearson Education, 2nd edition
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 6th edition.
3. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill.
4. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education
5. Ashfaque Ahmed, The SAP Materials Management Handbook, CRC Press Publication. 2014 edition.
6. Martin Murray & Jawad Akhtar, Materials Management with SAP ERP: Functionality and Technical Configuration, SAP Press; Fourth edition.
7. P. Gopalakrishanan, M. Sundaresan, Materials Management: An Integrated Approach, Prentice Hall India

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mg45/preview
- https://nptel.ac.in/courses/110106045
- https://www.udemy.com/course/sap-mm-training/
- https://www.udemy.com/course/sap-s4hana-mm-sourcing-and-procurement/
- https://nptel.ac.in/courses/110105095
- https://www.tutorialspoint.com/sap_mm/sap_mm_overview.htm
-

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case study of companies example Amazon, Flipkart, Parle, DMart, Reliance etc can be discussed

27.09.2022

Semester VI

ANALYSIS AND SIMULATION LABORATORY			
Course Code	**21MRL66**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2*-0	SEE Marks	50
Credits	01	Exam Hours	03

**** Additional one hour may be considered for instructions, if required***

Course objectives:

Students will be able

- To acquire basic understanding of Modelling and Analysis software
- To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the results pertaining to various parameters like stresses and deformations
- To compare the results of analytical models introduced in lecture to the actual behavior of manufacturing
- To discuss and practice standard programming techniques of manufacturing and their applications.

Sl.NO	Experiments
1	Study of a FEA package, modelling and stress analysis of Bars of constant cross section area, tapered cross section area and stepped bar
2	Modelling and stress analysis of Trusses – (Minimum 2 exercises of different types)
3	Modelling and stress analysis of Beams – Simply supported, cantilever, beams with point load , UDL, beams with varying load etc. (Minimum 4 exercises)
4	
5	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)
6	Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software
7	
8	CNC part programming using CAM packages: Simulation of Turning simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master-CAM.
9	CNC part programming using CAM packages: Simulation of Milling simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master-CAM.
10	Simulation using packages like MATLAB 1. Falling sphere with viscous drag – Investigate velocity versus time plot; & simulate the fall. 2. Frequency response for a spring-mass system; simulation of the oscillations. 3. Simulation of simple servo-mechanism feedback system in time domain.
11	
12	
13	Simple 3D Printing Model : Creating Simple 3D model (example cube, gear, prism etc) in CAD software and printing the model using any 3D Printer (FDM/SLA/SLS printer)

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Use the modern tools to formulate the problem, create geometry, descritize, apply boundary conditions to solve problems of bars, truss, beams, and plate to find stresses with different-loading conditions.

CO2: Simulate the manufacturing processes and vibration related problems

CO3: Create components through additive manufacturing technique

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. A first course in the Finite Element Method, Logan, D. L, Cengage Learning, 6th Edition 2016.
2. Finite Element Method in Engineering, Rao, S. S, Pergaman Int. Library of Science 5th Edition 2010.
3. https://nptel.ac.in/courses/112102103
4. https://onlinecourses.nptel.ac.in/noc19_me46/preview
5. https://nptel.ac.in/courses/112103306

27.09.2022

MARINE ENGINEERING

Semester-VII

MARINE AUXILIARY MACHINERY & SYSTEMS			
Course Code	**21MR71**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- A theoretical Knowledge of the auxiliary equipment on ships and the engine room layout.
- A knowledge of engine room pipeline systems and the fittings.
- A knowledge of pumps and pumping systems.
- A Knowledge of the heat exchanger systems and steering systems.
- Understanding of boilers and its maintenance.
- Understand the working of deck machinery systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

ENGINE ROOM LAYOUT , PIPING SYSTEMS AND FITTINGS

Layout of main and auxiliary machinery in Engine Rooms in different ships. Expansion joints in pipelines, Bilge – ballast, fuel oil bunkering and transfer system, bunkering procedure. domestic fresh water and sea water (Hydrophore) service system, drinking water system, Safety system - fire main.CO_2 and sprinkler systems , Valves, Cocks , Packing, Joints, Filters And Strainers .

Straight way cocks, right angled cock, T-cock, spherical cock, Boiler gauge glass cock (cylindrical cock). Globe valves, SDNR valve, swing check valve (storm valve), gate valves, butterfly valves, relief valves, quick closing valves, pressure reducing valves, control valves, change over valve chests, fuel oil transfer chest, valve actuators, Packings, Insulation of materials, Seals , filters in engine room

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

PUMPS & OTHER AUXILIARIES

Types of pumps for various requirements , Working principle and their characteristics, performance and application in ships – centrifugal pumps – gear pumps – screw pumps, Lobe pumps and reciprocating pumps bilge, ballast system ,applicable to tankers Pollution prevention equipment – 15 ppm Oily water separator, sewage treatment plant, and incinerator, - operation – sludge handling system

Purifiers & Clarifiers (FO & LO), Fresh water Generators. Domestic fresh water system. Main air compressors – Working principles, arrangements and operation –Refrigeration & Air conditioning system including ducts.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

HEAT EXCHANGERS: Principle of surface heat transfer – description, contact heat transfer, construction of shell and tube type – flat plate type, single and double pass – lubricating oil coolers, fuel oil heaters, fresh water coolers, compressed air coolers, Main Engine charge air cooler, materials used in all the above heat exchangers, expansion allowance – temperature controls effect of air in the system
Working principle and operation of Purifiers (LO and FO) and Main air compressors
STEERING SYSTEM: Hydraulic Telemotor system (Transmitter and receiver), hydraulic power unit – hunting gear heleshaw pump principle, construction and operation – pawl and ratchet mechanism, 2-ram and 4-ram steering gear – electric steering gear, principle and operation – Hunting gear and emergency steering gear.
Electrohydraulic steering gear, Rotary vane steering gear – principle – construction – operation – safety features, relief, isolating and bypass valves, steering system regulations and testing – troubleshooting

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

MARINE BOILERS AND MOUNTINGS
Types of Boilers - smoke and water tube and composite, Stresses in boilers refractory, boiler mountings, boiler water treatment and tests, boiler burners, cold start of boiler, shutting down of the boiler, boiler feed water system. Boiler FO system. Burners and forced draft fans. Economizer, Steam distribution system. Condensate system. Water trap and steam trap, Steam pipe insulation

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

DECK MACHINERY AND SYSTEMS
Working and construction of Mooring winches. Capstan ,Windlass and Anchor wash, Chain locker, bilge pumping arrangement . Deck hydraulic system, Derricks and cranes – electric and hydraulic, Gantry cranes. Life Boats & Life rafts, and Rescue bots .

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :
CO1: Locate and define various types of auxiliary machines, systems : piping systems, seals, valves, heat exchangers, pumps ,steering, sopep equipment and boiler systems (L1)
CO2: Classify and compare various fuel, lubricating and cooling systems, pumps, heat exchangers, boilers , cranes(L2)
CO3: Explain working of various piping systems in ER, pumps, heat exchangers, steering systems, seals, boilers in ER, capstan (L2)
CO4: Apply the principles of Materials science , fluid dynamics and heat transfer to select and operate piping systems, valves, pumps, steering systems, boilers, deck machinery (L3)

27.09.2022

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. D.W. Smith, —"Marine Auxiliary Machinery '', 6th Edition, Butter worths, London, 1987.
2. H.D. McGeorge, — "Marine Auxiliary Machinery '', 7th Edition, Butter worth, London,2001.

Reference Books:

1. H.D. McGeorge, — "General Engineering Knowledge", 3rd edition, Butter worth – Heineman, London, 1991.

Web links and Video Lectures (e-Resources):

- https://www.dieselduck.info/machine/index.html
- https://onlinecourses.nptel.ac.in/noc21_ch52/preview
- https://www.tlv.com/global/TI/steam-theory/types-of-valves.html

27.09.2022

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Tracing of pipelines from ships piping manuals
- Industrial visits to manufacturing units of valves and pumps.
- Make models and charts on the working of pumps, steering, and boilers.
- Overhauling Of Auxiliary Machine Components at a ship-in campus

27.09.2022

Semester-VII

ENGINE ROOM MAINTENANCE			
Course Code	**21MR72**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	02	Exam Hours	03

Course objectives:

- A knowledge of Watch-keeping of Engine Room in various types of ships and to prepare for Class IV MOT Examinations.
- A knowledge of safe watch keeping practices in the engine room.
- A knowledge of troubleshooting auxiliary machinery and its components.
- A knowledge of troubleshooting of the main engine and its components.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1	**8 HOURS**
MAINTENANCE BASICS : Definition, Types of maintenance, Differences between inspection overhaul and repair, Risk assessment and checklists , Types of checklists on a ship, Permit to work system, Hot work precautions, PMS systems on board ships with examples, Stores and spares management on ships, Ordering of Stores and spares, Critical spares-spares to be carried as per classification society for ER machinery, Differences between plant maintenance on shore and on ships, Non Conformities, Documents to be kept with respect to maintenance, externally generated documents, internally generated records, Identification and testing of critical equipment. Safe working Practices	
Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2	**8 HOURS**
TROUBLESHOOTING OF MARINE DIESEL ENGINES: (Maine engine and Gen diesel engine) Troubleshooting related to various types of marine diesel engines – Alarms. causes, effects, remedies and prevention of diesel engine not turning on Air and Fuel, knocking at TDC and BDC, black smoke in funnel, poor compression and combustion, early or advanced injection, turbocharger surging, scavenge fire, Air starting line explosion, crankcase explosion, exhaust uptake fire, Bearing failure, Sump contamination and Under size crank pin bearing in Generator Diesel engine	
Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3	**8 HOURS**

Troubleshooting of Auxiliaries -

Alarms, Causes, effects, remedy and prevention in auxiliary machinery like :

Boilers, Purifiers, Heat exchangers, Air compressors, Cold chamber refrigeration system, AC compressor and AC system, Fresh water generators, Hydrophore, Centrifugal pump, Reciprocating Pump and Oil pumps

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

MAINTENANCE OF ENGINE COMPONENTS:

Checking of foundation bolts, Checking of crankshaft deflection. Checking tie rods tension, Inspection of crankcase (checking of all clearances) and camshaft, Dismantle inspection and reassemble of main bearings, cross head bearings & bottom end bearings, Dismantle, overhaul and assembly of Cylinder cover and its mountings, piston, piston rings and piston assembly, stuffing box, Cylinder liner and cylinder lubrication, Thrust bearing, running gears inspection, chains drive inspection and tensioning.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

DRY DOCKING:

Dry dock Planning,Dry dock works. Dry docks types. Vessel (particularly tanker) readiness for dry dock. Docking, removal and mounting of propeller, Removal of aft seal. Removal of propeller shaft. Propeller drop, rudder drop and other clearances, Maintenance of propeller, rudder, sea chest and undocking procedure. Bottom plug, Engineer role in the dry dock.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Identify and define maintenance practices, problems arising in main engine, aux engine, engine components and dry docking(L1)

CO2: describe different procedures, troubles in main engine, auxiliary systems, components, dry docking of ships (L2)

CO3: Explain actions to be taken during spare management, during trouble shooting of main engine, Aux machines, and dry docking of tankers.(L2)

CO4: Identify and interpret alarms, faults during maintenance, failure of Main Engine, Aux Machines, when fixing propellers in drydock. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester

5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 2 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. A.S.Tambwekar,"Watch Keeping for Marine Engineers", Bhandarkar Publications; Third Edition,ASIN : B06XPFPWF7,2014
2. Vikram Gokhale & N.Nanda," Marine Engineering Practice and Ship safety and Environmental protection", 3rd Edition, Engee Enterprises Mumbai, 2002.
3. Heinz P. Bloch, Fred K. Geitner, "Machinery Component Maintenance and Repair" 3rd Ed. An imprint of Elsevier, 2010.
4. Elstan.A. Fernandez., "Marine Electrical Technology", 4th Edition, "Sterling Book House", Mumbai, 2004.

Reference Books:

1. IME Manuals and Ships Marine Manuals.
2. Instructions for S70MC MAN B&W engines. Volume II. Maintenance. Edition 5,2009
3. Daihatsu Diesel Engine instruction book, Operation & maintenance manual for Daihatsu Diesel Engine Model – DV26, Model 6 PKT – TB-16.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=5Fs_81baXnk&list=PLcMTKBdlRako6-eaeYMAMzxPkBV9pFUhS
- https://www.youtube.com/watch?v=noZAiPJcSBc
- https://www.youtube.com/watch?v=3wU-FBaz_pM

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Discussions on service letters by the manufacturers to the ships
- Visit to ship/shipping campus/service center to see the overhaul of the machinery
- Case studies on bad maintenance practices and their effect on machinery.

27.09.2022

Semester-VII

SPECIAL DUTY VESSELS			
Course Code	**21MR731**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To give the students a knowledge of Oil Tankers and their construction.
- To make the student aware of Gas Tankers and their systems.
- To gain a knowledge of cargo operation on Tankers.
- To have a knowledge of dangerous cargo and the precautions to be taken.
- To have a knowledge of the operation of special duty vessels.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Oil Tankers basics and crude oil tankers:

Origin of double hull ships, their usefulness and superiority over conventional single skin ships, IMO requirements, schedule for phasing out single hull tank vessels of different sizes. Types and classification, construction, cargo pumps and Pipeline systems – Ring main – Direct Line – Combined – Free flow system – Stripping lines. Safety devices associated with loading and discharging.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Gas Tankers:

Principles of Gas Carrier Design: Design standards and ship types, Cargo containment systems, materials of construction and insulation, Gas carrier types.

Equipment And Instrumentation: Cargo pipelines and valves, cargo pumps, cargo heaters, cargo vaporizers, reliquification plants and boil off control, cargo compressors and associated equipment, IG and nitrogen gas systems, electrical equipment in gas Dangerous spaces.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Oil tanker cargo and IG operations:
Lining up pipe lines and cargo operations – loading more than one grade – discharging –ballasting – precautions – ship / shore check list safety goods – sources of ignition on – static electricity – precautions to prevent ignition due to static electricity cargo operations when not secured alongside – procedure if oil spill occurs – oil record books. Uses of inert gas during tanker operating cycle. Tank washing: Procedure – portable and fixed machines – tank washing with water –washing atmospheres – crude oil washing (COW) – advantages and disadvantages of COW – operating and safety procedures – gas freeing – pressure vacuum values – "Load on Top" system (LOT) regulations and operation – Segregated Ballast Tanks (SBT).

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

Chemical Tankers and product tankers
Chemical cargo types, properties and Hazards, Cargo information. IBC code. Tankers for chemicals, general arrangement and survival capability and tank location. Cargo tanks material and coating. Cargo heating system. Cargo pumps – Deep well Framo pump, Firefighting system, Product tanker - Compliance of MARPOL – Products as specified in MARPOL.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Operation of Special Duty vessels:
Introduction to operations on: Bulk carriers – Bulk Grain and ore , Container ships size and layout ,Passenger ships - General Arrangement –Difference between Cruise ships and special trade passenger ships (only in India). Indian Passenger ship requirement for construction and operation. Solid blast. Charged fire main. Sprinkler system. Passenger ship A certificate and B certificate

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :
CO1: Identify and define various types Tankers,special duty vessels and its operations (L1)
CO2: Classify the tankers and special duty vessels (L2)
CO3: Explain cargo operations and regulations for safety for all types of tankers, passenger and Special duty vessels (L2)
CO4: Apply principles of cargo operations to specific scenarios of all types of tankers, passenger and special duty vessels. (L3)

Assessment Details (both CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together
Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Lavery, "Ship board operation",2nd Edition, 2018,Routledge , ISBN-13 : 978-1138132634
2. David House, Seamanship Techniques: Shipboard and Marine Operations ,5th Edition ,2018, Routledge ,ISBN-13 978-1138676114
3. D. J. House,Cargo Work For Maritime Operations,8th edition,2005, Elsevier Butterworth-Heinemann,ISBN:9780750665551

Reference Books:

1. International Maritime Organization, IMDG code: international maritime dangerous goods code,39th edition,2018,IMO, ISBN-10 : 9280116827

Web links and Video Lectures (e-Resources):

- https://www.imo.org/en/OurWork/Safety/Pages/DangerousGoods-default.aspx
- https://www.dtwd.wa.gov.au/sites/default/files/teachingproducts/MAR041_CCBY.PDF
- https://www.imo.org/en/OurWork/Safety/Pages/Cargoes.aspx
- https://www.dieselduck.info/index.html
- https://www.youtube.com/watch?v=wiT_SillgEc

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case study on cargo operations and spills
- Talks from engineers working on tankers and gas carriers.

Semester-VII

27.09.2022

MARINE CORROSION AND PREVENTION			
Course Code	**21MR732**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To impart knowledge to the students about Corrosion and their influence on Materials and how to prevent corrosion with latest techniques.
- Knowledge of the chemistry of corrosion.
- Knowledge of the corrosion process and the degradation of metals.
- Knowledge of corrosion in engines.
- Knowledge of the corrosion preventive techniques

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

Electrochemistry of Corrosion:
Introduction, definitions and types, Electrochemical cells -definitions and principles, Potential measurements – galvanic cells and concentration cells, EMF and Galvanic series – bimetallic couples, Eh-pH diagrams – fundamental aspects, Construction of Eh – pH diagrams. FeH_2O-O_2 diagram, Copper, Aluminum and general corrosion diagrams. Different forms of corrosion - uniform, galvanic, crevice, pitting, intergranular, selective leaching, erosion, stress corrosion cracking - their characteristic features, causes and remedial measures

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Corrosion and Degradation of Metals:
Application of the thermodynamics and kinetics of electrochemical reactions to the understanding of corrosion phenomena such as oxidation, passivity, stress corrosion cracking, and weld decay. Environmental degradation of ceramics and polymers. Applications to current materials degradation problems in marine environments, petrochemical and metallurgical industries, and energy conversion systems.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Electrode kinetics and polarization phenomena:

Definitions- Electrode Kinetics and Polarization, Biological aspects of corrosion, Microbial influenced corrosion (MIC), MIC–Bacterial transport, attachment and affected materials, MIC - Role of aerobic and anaerobic microorganisms, Mechanisms and models for SRB corrosion, MIC and Biofilms, biofilm studies, MIC – Prevention and control.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

Corrosion in Marine Diesel Engines:

Corrosive wear of cylinder liners – Reasons and remedies. Corrosion In Boiler, Effect of corrosion while boiler not in service – preservation to avoid corrosion, Hull Plate Preparation, Plate preparation during building and repair periods - Atmospheric corrosion Mill scale – flame cleaning – Acid Pickling – Blast cleaning – causes of paint failure – shipboard preparations for painting – power wire brushing – power discing – air hammer – high pressure water blasting – sand blasting ,shot blasting

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE 5 **8 HOURS**

Corrosion And Its Prevention:

Mechanism of corrosion – Chemical corrosion – Electrochemical corrosion – Anomic & cathodic protection – forms of metallic coatings – anodizing – phosphating, Physical vapour deposition technologies, ion plating, sputter deposition, reactive deposition, magnetron sputtering, general aspects of PVD (production sequence, advantages and disadvantages, microstructure), summary of applications, duplex treatments. Corrosion-wear of surface engineered materials, the corrosion-wear synergy. Basic facts of corrosion - cathodic and anodic coatings, coating defects. The passive film and it's breakdown by mechanical action.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Understand the basics of Corrosion (L2)

CO2: Understand the mechanism of marine corrosions and the microbial corrosions (L2)

CO3: Identify the factors affecting corrosion (L3)

CO4: Select appropriate prevention methods of Corrosion (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books:

1. W.D. Callister, Jr., D.G. Rethwisch, Materials Science and Engineering: An Introduction, John Wiley & Sons , 2009, 978-0-470-41997-7.
2. J.R. Davis, Corrosion: Understanding the Basics, ASM International, 2000, 0-87170-641-5.
3. M.G. Fontana, Corrosion Engineering, McGraw-Hill, 1986, 0-07-021463-8.
4. Lavery, H.I.,"Shipboard operations" Institute of Marine Engineers Publication.
5. Schweitzer, „ Fundamentals of Corrosion",1st Ed. Taylor & Francis, Indian Reprint 20129 (Yesdee Publishing Pvt. Ltd.).

Additional References:

1. Francis Laurence LaQue , " Marine corrosion: causes and prevention", 1st Ed., Wiley, 1975
2. Claire Hellio, Diego M. Yebra, Pinturas Hempel S.A., "Advances in Marine Antifouling Coatings and Technologies", Woodhead Publishing, 2009

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mm36/preview
- https://www.sciencedirect.com/topics/engineering/marine-corrosion
- https://link.springer.com/chapter/10.1007/978-3-319-16649-0_6
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5506973/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Devise an experiment to study the corrosion of a steel bar in salt water and report the findings.
- Review of research papers on marine corrosion.
- Case studies on marine corrosion of offshore structures.

27.09.2022

Semester-VII

SHIP FIRE PREVENTION AND SAFETY			
Course Code	**21MR733**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Conceptual knowledge of basics of the chemistry of fire.
- Knowledge of rules and regulations governing passive and active firefighting on board ships.
- Knowledge of fixed and portable fire fighting equipment and their operation.
- Understanding of the dangers to human life because of fire.
- Knowledge of emergency procedures for fire fighting on ships.
- Human behavior affecting firefighting and team management during firefighting.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Basics of firefighting

Chemistry of fire, fire triangle and fire tetrahedron, aspects of combustion-types of combustion including spontaneous combustion, flash point , fire point, limits of flammability, UEL, LEL, classification of fire and the properties of materials in each class of fire, firefighting mediums and their properties, combustion products and their effect on human life and safety

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Fire Protection Built In Ships

SOLAS convention, requirements in respect of materials of construction and design of ships, (class A, B, type BHDS), fire detection and extinction systems, fire test, escape means, electrical installations, ventilation system and venting system for tankers. Statutory requirements for firefighting systems and equipment8 on different vessels, fire doors & fire zones

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Fire Fighting Equipment and Detection Systems

Types of detectors, selection of fire detectors and alarm systems and their operational limits. Commissioning and periodic testing of sensors and detection systems. Fire pumps, hydrants and hoses, couplings, nozzles and international shore connection, construction, operation and merits of different types of portable, non-portable and fixed fire extinguishers installations for ships, water-mist fire suppression system.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

Fire Control and Safety Systems on Ships

Action required and practical techniques adopted for extinguishing fires in accommodation, machinery spaces, boiler rooms, cargo holds, galley, etc. Fire fighting in port and dry dock. Procedure for re-entry after putting off fire, fire organization on ships, shipboard organization for fire and emergencies. Fire signal and muster. Fire drill. Fire control plan, Leadership and duties, human behaviour

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Safety Measures and First Aid

Special safety measures for preventing, fighting fire in tankers, chemical carriers, oil rigs, supply vessels, and fire fighting ships - Safe working practice with respect to fire on board ships. First aid, Rescue operations from affected compartments

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Identify and define various types fires , firefighting equipment, control measures, first aid(L1)

CO2: Classify fires, fire protection, detection systems, safety measures and safety systems (L2)

CO3: Explain fires chemistry, fire protection in construction ,types of detection systems, safety measures on board and first aid(L2)

CO4: choose portable extinguishers, fire protection, detection systems, safety procedures depending on the fire and ship (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Rushbrook, Frank. Rushbrook's Fire Aboard: The Problems of Prevention and Control in Ships, Port Installations and Offshore Structures. United Kingdom, Brown, Son & Ferguson, 1998.
2. Cowley, James. Fire Safety at Sea. United Kingdom, Institute of Marine Engineering, Science and Technology, 2002.
3. FSS Code: International Code for Fire Safety Systems. United Kingdom, International Maritime Organization, 2016.

Reference Books:

1. SOLAS Consolidated Edition 2020, International Maritime Organization; 7th ed.,2020,ISBN-13 : 978-9280116908
2. MARPOL Consolidated Edition 2018 (Vol A & B), Bhandarkar Publications; 2016th edition, 2018,ASIN : B071DFXF3H
3. R. H. B. Sturt, "**The Collision Regulations**", 2nd Edition, Lloyd‟s of London Press Ltd., London,
4. Gupta, R.S.,"**A Hand Book of Fire Technology**", 2nd Ed., University Press, 2011

Web links and Video Lectures (e-Resources):

- https://www.sqlearn.com/fire-protection-and-fire-fighting-on-ships/
- https://www.imo.org/en/OurWork/Safety/Pages/FireProtection-default.aspx
- https://rules.dnv.com/docs/pdf/gl/maritimerules2016July/gl_vi-3-4_e.pdf
- https://nptel.ac.in/courses/110105094

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise visit to fire stations
- Case study on fire accidents on board ships
- Report and presentation on first aid for burns.
- Presentation on latest review on research papers in firefighting technology.

Semester- VII

IMO AND MARITIME CONVENTIONS			
Course Code	**21MR741**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- A theoretical Knowledge of the regulations governing international shipping
- Basic knowledge of the IMO conventions.
- A understanding of ISM
- Basic understanding of surveying and its regulations.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

IMO and Local administration:
History of IMO, structure of IMO, Explicit and tacit acceptance, International organizations associated with IMO, classification societies and their role in shipping, IMO and the Sustainable Development Goals, Background of classification societies, Principles and scope of classification, Certification of component and materials, Survey of ships during construction, Survey of ships in operational phase, requirement of class certificate, Shipping rules and organisations in India.

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

SOLAS and safety:
Overview of SOLAS, Applicability, SOLAS Requirements for machinery installation (Regulations Chapter II-I, Part C). UMS requirements (Regulations Chapter II-I, Part C), Arrangement for oil fuel, Lubrication oil and other flammable liquids (Chapter II-2 Part B Reg 4.2), Firefighting (Chapter II-2 Part C Reg 10) and Escape Chapter II-2 Part D Reg 13, 3.1, 3.3, 3.4, and 4), Operational requirements (Chapter II-2 Part E –Reg 14,15,16).SOLAS Rules for LSA – (Chapter III –, Part B Sec - 1 –Reg 7,Reg 8, Reg 9, Sec III –Reg 31, Reg 32 and 33)

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

27.09.2022

MODULE-3	8 HOURS
SOLAS and Polar code: Chapter Xi-1 –Enhanced maritime safety , Chapter XII – Additional safety for Bulk Carriers and Enhanced surveys, Ship identification Number , Requirement of Port State control, CSR Chapter XII –Damage stability, Structural strength (Reg 5) , Solid bulk cargo density declaration, (reg 10) Loading instrument (Reg 11) , Hold space, ballast and dry space water level detectors (Reg 12), Availability of pumping systems (Reg 13) Polar code: introduction-Operating in polar waters-Main sources of hazards-Definitions-Regulatory framework-Overview-Application-General principles-Philosophy of the Code-Structure of the Code-Ship categories-Mean Daily Low Temperature (MDLT)-Polar Service Temperature (PST)	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE-4	**8 HOURS**
MARPOL and Load Line: Over view of MARPOL – Applicability Annex 1 – Standard discharge connection (Reg 13), Reg 14, Control of discharge of oil (Reg 15), Reg 16, Reg17, Reg 31 Control of discharge of Chemical, sewage, garbage, emission. Tier I, Tier II and Tier II engines. Overview of Load line – Rules for side scuttles, Air Pipes, windows, Hatch covers and Ventilators and railings	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
MODULE-5	**8 HOURS**
ISM: ISM - Objective - Definition of company, SMS, DOC, NC and major NC, Anniversary date. Functional requirement of SMS, Application. Company Responsibility and Authority, Designated Person (S) Masters Responsibility and Authority. Documentation for ship board operations. Emergency drills. Crew familiarization. Maintenance of the ship and equipment Audits and certification ISPS – Objective - CSO and SSO, ship security assessment. Ship Security Plan, security levels, Requirement of security level 1, 2 and 3 of ships. Ship security alert system (SOLAS Chapter XI – 2, Reg 6) Security equipment on ship and Port facilities. Security training and onboard drills – Port security.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.
Course outcome (Course Skill Set) At the end of the course the student will be able to : CO1: Identify and define the international and local maritime organizations, SOLAS,MARPOL,ISM, and its related codes and Polar Code (L1) CO2: Classify organizations based on conventions, classify surveys, SOLAS amendments, MARPOL Annexes, ISM chapters, safety requirements for polar code (L2) CO3: Explain classification societies, SOLAS chapters for machinery ,polar code, Load line convention, Polar code(L2) CO4:Apply principles of management and engineering to study surveying, building ships as per SOLAS; MARPOL, ISM, Polar Code (L3)	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Capt.DaraE.Driver, "Advanced Shipboard Management", I Edition, Rumar Publications, Mumbai, 1985.
2. Pinto, "Maritime Law", Bhandarkar Publications, 1998

Reference Books:

1. SOLAS Consolidated Edition 2020, International Maritime Organization; 7th ed.,2020,ISBN-13 : 978-9280116908
2. MARPOL Consolidated Edition 2018 (Vol A & B), Bhandarkar Publications; 2016th edition, 2018,ASIN : B071DFXF3H
3. Nilima, M.Chandiramani, "Carriage of goods by Sea and Multimodal Transport", 1st Edition, Saptarang Publication, Mumbai, 1996.

Web links and Video Lectures (e-Resources):

- https://www.imo.org/en/KnowledgeCentre/ConferencesMeetings/Pages/SOLAS.aspx
- https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx
- https://www.youtube.com/watch?v=Q7Espb0afMw
- https://www.imo.org/en/MediaCentre/HotTopics/Pages/SustainableDevelopmentGoals.aspx
- https://www.youtube.com/watch?v=X_x2_RTUiGM

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case study on SOLAS and MARPOL
- Report on the future of shipping with strict pollution regulations
- Report on shipping and sustainability in India.

27.09.2022

Semester-VII

MARINE ENGINEERING PRACTICE			
Course Code	**21MR742**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- The understanding of practices in main engine maintenance.
- The understanding of practices in auxiliary engine maintenance.
- The understanding of practices in air compressor and purifier maintenance.
- The understanding of practices in maintenance of propeller and shaft.
- The understanding of practices in maintenance of ancillary engine room machinery.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Main Engine:

Removal and maintenance carried out on : cylinder liners, cylinder heads, fuel valves, exhaust valves, starting air valves: The checks to be carried out after removal, liner removal and fitting, defects in liner, fuel valve testing, exhaust valve testing, removal inspection and fitting back of piston and piston rings, overhaul of piston, pressure testing of piston, various bearing clearances(cross head, main bearing), T/C maintenance.

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Auxiliary engine:

Maintenance of components such as Fuel valve, cylinder head, pressure testing of fuel valve, pressure testing of cylinder head, removal and checking of piston, piston rings, bottom end bearings, con rod, con rod bolts, removal of main bearing, air cooler cleaning and inspection, lube oil cooler cleaning and inspection, T/C removal and inspection of various components

Teaching- Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Air compressor:

Construction of tandem type piston, Removal and maintenance of plate type valves, testing of plate type valves, faults in plate type valves, checking of bumping clearance and adjustment of clearance, crankcase inspection and oil condition monitoring, inspection and pressure testing of intercooler, inspection and maintenance of air bottles, requirement of air bottle according to classification society.

Purifiers: Removal and inspection of purifier disc stack, maintenance of frictional brake, factors affecting the performance of purifier. Selection of gravity disc and use of nomogram table.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

Propellers and shaft:
Propeller Shaft system, shaft checks, coupling bolts- tapered, conventional, pilgrim type coupling bolt, Muff coupling, stern tube sealing arrangement, propeller mounting methods- keyed and keyless, pilgrim nut method, oil injection propeller mounting.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Sewage treatment plant:
Requirement according to MARPOL, Biological sewage treatment plant construction working, Plant maintenance and routines, Vacuum type sewage treatment plant working and maintenance.
Incinerator: Requirement according to MARPOL, Construction and maintenance of a shipboard incinerator.
Oily water separator: Requirement according to MARPOL, construction and working of Simplex type oil/water separator with coalesce, maintenance of OWS, oil content monitoring system.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :
CO1: Identify and define various components of main engine, Auxiliary engine, air compressor, purifier, propeller, Marpol equipment (L1)
CO2: Classify the maintenance of main engine, Auxiliary engine, air compressor, purifier, propeller, Marpol equipment based on running hours (L2)
CO3: Explain the procedure for overhaul of components in main engine, Auxiliary engine, air compressor, purifier, propeller and Marpol equipment (L2)
CO4: Apply the principles of maintenance for Main engine , Aux engine :liners, pistons and bearings, shaft sealing , marpol equipment and interpret values from various clearances and readings. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. J. Cowley,The Running and Maintenance of Marine Machinery, Institute of Marine Engineers, 1992 , 6th reprint
2. Paul A Russell, Leslie Jackson, Thomas D. Morton, Reeds Vol. 8: General Engineering Knowledge,6th Edition,2018,Bloomsbury, ISBN9781472952714

Reference Books:

1. Manuals for the machinery from the manufacturers

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=5Fs_81baXnk&list=PLcMTKBdlRako6-eaeYMAMzxPkBV9pFUhS
- https://www.youtube.com/watch?v=noZAiPJcSBc
- https://www.youtube.com/watch?v=Bkkk3S7G_8o
- https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx#:~:text=The%20International%20Convention%20for%20the,2%20November%201973%20at%20IMO.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Watch videos of maintenance from makers and discuss in a flipped classroom
- Visit a marine workshop or ship-in-campus.
- Case studies on maintenance service letters.

27.09.2022

Semester- VII

SHIPPING TRADE			
Course Code	21MR743	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- A comprehensive understanding of maritime trade.
- An understanding of the dynamics of cargo transport.
- The understanding of the pertinent maritime regulations.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Basic Concepts and the Geography of Maritime Trade:

Basic concepts of seaborne trade, Geography of Maritime Trade, Value added by seaborne transport, Oceans, distances and transit times, Maritime trading network, Europe's sea borne trade-North America's sea borne trade, South America's sea borne trade, Asia's sea borne trade-Africa's seaborne trade, Sea borne trade of the Middle east, Central Asia, Russia, Australia and Oceania.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

The Principles of Maritime Trade :

The Principles of Maritime Trade, building blocks of sea trade, countries that trade by sea, Trade theory and drivers of trade, Difference in production costs, Trade due to differences in natural resources, commodity trade cycles, Role of sea transport in trade, Transport of Bulk Cargoes, commercial origins of bulk shipping, the bulk fleet bulk trades, The principles of bulk transport , Liquid bulk transport, crude oil and oil products trade, Major dry bulk trades, minor bulk trades.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Transport of Specialized and General Cargoes:

Transport of specialized and general cargo , Sea transport of chemicals , LPG trade, LNG trade, Transport of refrigerated cargo, Unit load cargo transport, Passenger shipping, Transport of General cargo, origins of the liner service, Economic principles of liner operation, General cargo and liner transport demand, Liner shipping routes, liner companies, liner fleet, principles of liner service economics, Pricing liner services, Liner conferences and

cooperative agreements, Container ports and terminals.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

The Ship Providing Transport-the Design :

The Ship that provides transport, derived demand for ships, Seven questions that define a design, Ships for general cargo trades, Ships for the dry bulk trades, Ships for liquid bulk cargoes, Gas tankers, Non-cargo ships, Economic criteria for evaluating ship designs.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5 **8 HOURS**

Economics of Shipbuilding & Ship Breaking:

The role of merchant shipbuilding and scrapping industries, Regional structure of world shipbuilding, Shipbuilding market cycles, economic principles, shipbuilding production process, Shipbuilding costs and competitiveness, ship recycling industry, Regulation of the Maritime Industry, How regulations affect maritime economics.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Identify and define concepts of maritime trade , trade theory, principles of liner operation, ship design, ship recycling(L1)

CO2: Classify trade according to geography, cargo, types of bulk cargo, ship building processes (L2)

CO3: Explain value addition by shipping, major and minor bulk trades, liner trade, tanker design, regulation of ship recycling (L2)

CO4: Examine trades in various geographical areas, trade due to differences in natural resources, design criterias, liner conferences, role of building and scrapping industries. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Martin Stopford,Maritime Economics, 3rd Edition,Routledge, New York,2008,ISBN 9780415275583
2. Wayne K. Talley,Port Economics,2nd Edition,Routledge, New York,2018,ISBN 9781138952195

Reference Books:

1. Kevin Cullinane (2011) International Handbook of Maritime Economics Edward Elgar publishing.
2. Wayne k. Talley (2012) The Blackwell Companion to Maritime Economics, Wiley-Blackwell: U.K.
3. ICS (2014) Introduction to Shipping.

Web links and Video Lectures (e-Resources):

- https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-driving-prosperity/
- https://unctad.org/topic/transport-and-trade-logistics/review-of-maritime-transport
- https://www.seatrade-maritime.com/technology/martin-stopford-four-point-plan-modernise-shippings-business-models
- https://www.youtube.com/watch?v=j7RsRnYlz7I

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case study on Covid-19 and change in shipping routes.
- Case study on the Sagarmala project.
- Visit Dry docks or shipping offices

27.09.2022

Semester-VII

PORTS AND TERMINAL MANAGEMENT			
Course Code	**21MR751**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To familiarize the fundamental functions, operations, ownership and management structure of the ports and terminals.
- To understand the commercial, operational and technical components of ship management.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

PORT STRUCTURE AND FUNCTIONS

Definition - Types and Layout of the Ports – Organisational structure-Fundamental observations. Main functions and features of ports: Infrastructure and connectivity - Administrative functions - Operational functions. Main services: Services and facilities for ships - Administrative formalities - Cargo transfer - Services and facilities for cargo.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

PORT OPERATIONS

Berths and Terminals - Berth Facilities and Equipment - ship Operation - Pre- shipment planning, the stowage plan and on-board stowage - cargo positioning and stowage on the terminal - Developments in cargo/container handling and terminal operation - Safety of cargo operations - Cargo security: Measuring and evaluating performance and productivity.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

PORT DEVELOPMENT

Phases of port development - Growth in world trade - Changes in growth - Development in terminal operation. Shipping technology and port: Ship knowledge - Ship development and port development - Port time and ship speed - Other technical development affecting port

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

27.09.2022

MODULE-4	8 HOURS
FUNCTIONS OF SHIPPING Ship: Types of ships - Principal dimensions - Ship's tonnages (GT, NT, DWT) - Cargo carrying capacity. Ship owners, operators and managers: Ship manager - Structure of ship owning and management organizations - Ship's personal - Agents.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-5	8 HOURS
SHIP REGISTRATION, CLASSIFICATION AND INSURANCE Registration - Types of registries - Flag - Classification - Port State Control - Inspections - Surveys - Conditions of survey and inspections - Other surveys. Insurance: Hull and machinery insurance - General average - Salvage - Third party recoveries - Claims and handling - Protection and indemnity.	
Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Describe the features of ports, port operations, functions of shipping (L1)

CO2: Classify layout of ports, berth facilities, registries, hull and machinery, insurance (L2)

CO3: Explain port operations, port development, functions of shipping, insurance (L2)

CO4: Illustrate functions of ports, structure of ship owning and management, surveys .(L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.

2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. PATRICK M.ALDERTON. 2008, Port Management and Operations. Informa Law Category, U.K.
2. ICS .2011/12, Ship Operations and Management. London, UK.

Reference Books:

1. WORLD BANK. 2007, Port Reform ToolKit. World Bank, Washington.
2. MARIA G.BURNS. 2014., Port Management and Operations. CRS Press, U.K
3. JOHN. W. DICKE. 2014, Reeds 21st Century Ship Management. Bloomsbury Publishing, U.K.
4. LUNY.H.V., LAI K.-H., CHENG T.C.E. CHENG. 2010, Shipping and Logistics Management." Springer, U.K.

Web links and Video Lectures (e-Resources):

- http://shipping.nic.in/ (Ministry of Shipping, Govt. of India)
- http://ipa.nic.in/ (Indian Port Association)
- www.ippta.org.in (Indian Private Ports and Terminals Association)
- www.consulting.xerox.com/case-studies/...shipping-co/enus.html (International Shipping Company Case Study)
- www.sugarcrm.com/industry/shipping-and-transport/case-study(CRM Shipping and Transport Case Studies)
- http://businesscasestudies.co.uk (Shipping Sector - Case Studies)

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Business study on International ship management company
- Visit to ports, shipping office, or a stevedoring company
- Case study on CRM shipping and transport system

27.09.2022

Semester-VII

TRANSPORT AND LOGISTICS MANAGEMENT			
Course Code	**21MR752**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- The foundation for understanding the concepts of Logistic Management.
- Topics are designed to explore managerial principles and practices.
- Concepts of international trade and commerce.
- To have an understanding of operation research and quantitative techniques.
- To have an understanding of Port Management.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

INTRODUCTION:

Introduction to Logistics. Logistics and Competitive Strategy-Competitive advantage, Gaining competitive advantage through logistics-The mission of logistics management. Management principles and practices, Management information system, Human resources management.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-2 **8 HOURS**

MANAGERIAL ECONOMICS:

Managerial economics, Finance accounting, Cost & Management accounting, International financial management. The shipping cycle - Shipping cycle and loan finance decision - Main sources of shipping finance-Issue of shares- types of shares- listing of shares in International stock exchanges in shipping markets

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-3 **8 HOURS**

INTERNATIONAL TRADE AND COMMERCE:

International trade & commerce, International transport system, International transport Law, Transport economics, import-export documentation and procedure, Multimodal transport. Logistic & Operations management.

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE-4 **8 HOURS**

Quantitative techniques, Operation research, Research Methodology, Strategic management, International marketing (without numericals)

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

MODULE 5 **8 HOURS**

PORT AND TERMINAL MANAGEMENT:

Port and Terminal Management, Port Economics, Logistics and Supply Chain Management, Port Pricing and Finance, Port Marketing & Services. Port ownership structure- Types of port ownership and administration - Organizations concerning ports - Boards governing the ports - Port management development

Teaching-Learning Process	1. Power-point Presentation 2. Video demonstration or Simulations 3. Chalk and Talk.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Describe the transport and Logistics strategy, Management principles and practices. (L1)

CO2: Understand the concept of managerial economics, international trade and commerce, import-export documentation and procedure. (L2)

CO3: Understand the quantitative techniques, operation research, and Research methodology.(L2)

CO4: Illustrate working of port management, organizational and administrative structure, personnel management, training and emergency drills of ships. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

27.09.2022

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books:

1. MARTIN, CHRISTOPHER, Logistics and Supply Chain Management. 2 nd edition. Pearson: New Delhi.
2. AGRAWAL, D. K. (2003) Textbook of Logistics and Supply Chain Management. MacMillan: New Delhi

Additional References:

1. PATRICK M.ALDERTON. 2008, Port Management and Operations. Informa Law Category, U.K.
2. LAMBERT, D.M., STOCK J.R. & LISA M. ELLRAM (1998) Fundamentals of Logistics Management. Irwin-McGraw-Hill: UK

Web links and Video Lectures (e-Resources):

- https://archive.siam.org/journals/plagiary/1814.pdf
- https://www.udemy.com/course/transportation-and-logistics/
- https://www.coursera.org/learn/supply-chain-logistics
- https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/indias-postpandemic-logistics-sector-the-need-for-technological-change#:~:text=In%202019%2C%20the%20McKinsey%20Global,least%20%24320%20billion%20in%202025.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Case study on the predicted growth of logistics in India.
- Visit to a logistics or shipping firm and write on the organisational structure.
- Trace the supply chain of the mobile phone that comes to the student and make a chart